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School of Business

WAGE-PAYMENT PLANS THAT REDUCED PRODUCTION COSTS

EDITED BY
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CONSULTING INDUSTRIAL ENGINEER
DIRECTOR, INDUSTRIAL COURSES LA SALLE EXTENSION UNIVERSITY
LT. COL. ORDANCE, U. S. R.

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PART I

BASIC CONSIDERATIONS UNDERLYING THE INSTALLATION OF WAGE-INCENTIVE PLANS

I

THE GROWING TENDENCY TOWARD THE USE OF INCENTIVE WAGE PLANS

IN 1924, the National Industrial Conference Board undertook a study of over 1,000 plants employing over 400,000 workers, and found that 44 per cent were making use of some incentive plan.

In 1927, the Sherman Corporation made a survey of over 1,100 companies employing over 500,000 workers, and found 49 per cent using incentive plans. They found that in plants devoted to automotive products, 65 per cent used incentive methods which fact undoubtedly has a real connection with the outstanding efficiency attained in that group.

In 1928, the National Metal Trades Association surveyed 672 of their members' plants and found that 54 per cent used some form of incentive plan.

THE REASONS FOR THIS TENDENCY

The traditional employer viewpoint was to consider wages as an element of cost of expense necessary to manufacture or market an article or product.

The employer believed, and the belief was often well founded, that employe output in quantity and quality is often not commensurate with the money paid out for it.

To the employee, on the other hand, the pay-envelope has been and ever will be, the supreme ambition. To him it means food, clothes, home, education for children, recreation, and an automobile.

The wage-incentive system reconciles both viewpoints. It makes possible increased production and lowered costs, hand in hand with greater, employee-earnings. The increased earnings create greater consumer purchasing ability.

HOW WAGE INCENTIVE SYSTEMS ACT

Incentive encourages, stimulates, and spurs to action. Men work because they desire the additional advantages offered by the system.

Most of the holding back that is acknowledged to occur in industry and business is because employes lack sufficient incentives. Knowing that he is definitely to share in the savings and profits it is possible to earn, it is but a question of time and effort until most of the workers are able to control and regulate their activities and influence the actions of others to bring about results which it had not been anticipated would be possible.

A fair exchange is the basis, not only of business success but of wage-incentive systems. Workers must have incentives that appeal to them as worthy of the struggle and efforts which must be made to obtain them. The employer and other executives, on consideration, will find that it was some sort of incentive that stimulated him to the efforts which were necessary in order to acquire his present position. Without incentives he would have lost interest in his work.

Certain prerequisites which will be mentioned later, are necessary to bring results. For these reasons, the installation of wage-incentive systems means more knowledge and more studying than is entailed in an understanding of wage-payment plans by themselves. The extra pay features of these plans it is true, appeal to certain human desires, such as pride, self-preservation, advancement, home, pleasure, or money, the realization of which awaken interest and impel action, but in order to pave the way for these desires to get into action, intelligent and painstaking preparatory work is necessary before a wage-incentive system is installed.

Certain important knowledge is needed by the man who is to direct the installation of a wage-incentive system, namely, knowledge which enables him to set up conditions which are essential prerequisites, which result in maximum benefits to the employer and which conditions enable the worker to see that definite rewards and accomplishments are bound to follow regularly as a direct result of performing work exceptionally well.

Incentives to employes work out in a practical way only when they are founded on the results of specific types of analysis, classification, and standardization, coupled with a desire to give each person a just reward for his service. When incentive plans are based on such methods and purposes without any desire to take advantage of workers in any way, there is bound to be cooperation. What this knowledge consists of will now be explained:

BASE RATES

The term "base rates" is used to indicate the retainer rates that are paid to men who employ them, to secure their willing services irrespective of any additional incentives for better or increased production. Base rates represent the minimum rate of wages paid for work of a certain kind.

The base rate is the ordinary day rate or going wage which is usually guaranteed the worker in any incentive plan, whether he accomplishes the task or not. It is the rate he receives when he is working on jobs on which no standard has been set. An exception to this is usually made when he is being observed for time or motion study. Under these circumstances he is generally paid a bonus of 20 to 25 per cent over his base rate while he is being studied.

EMPHASIZING THE BASE RATE

It is always best to separate the employee's incentive wages from his base wages. If the total earnings of an employe are lumped together in the same pay-envelope or merged into a single pay check, there is danger that the value of his incentive earnings as a stimulus to increased interest and cooperation will gradually diminish. If wages are paid in currency it is best to use two distinct pay-envelopes —one, containing the regular wages figured according to the base rate; the other, containing the incentive earnings. If checks are used, a separate check should be written for the incentive earnings.

JOB CLASSIFICATION

Before we can intelligently establish base rates we need to classify all the jobs in the business. This classification is of two kinds:

(a) Classification by trades or occupation.

(b) By grades within each of the above.

Classification as indicated opposite (a) will usually disclose many conditions of unfairness and incompatibility of compensation when the first comparison is made with the departmental payrolls and the classification resulting from survey and analysis.

It will be found that due to lack of such classification and on account of liberality or favoritism by some supervisors, and ultra-conservatism on the part of others, certain individuals doing work requiring a low grade of intelligence, skill and training are being paid the same or even higher rates than are being paid to employees doing higher grades of work.

Classification as indicated opposite (b) is exceedingly important. Take an example for office work. If we have three grades of typists, three grades of stenographers, and two or three grades of secretaries, we have a basis of promotion based upon experience, skill, and responsibilities carried, which have a pronounced effect on ambition and labor turnover. What is true of office work is equally true of shop work.

FACTORS GOVERNING BASE RATES

After having classified and sub-classified our trades and occupations, we are ready to investigate the factors that will affect the minimum and maximum wages properly applying to each of them in any particular locality and business.

We will need to secure information on the following factors as they exist in the community:

(a) Prevailing rates in the occupations and subdivisions of each occupation.
(b) Trade union scales.
(c) Labor supply available.
(d) Mental and physical requirements for each subdivision of each occupation, whether low, ordinary, or high.
(e) Experience and skill required in the particular business as compared with other businesses in the community.
(f) Standards of living of the social group represented in each occupation.
(g) Minimum wage laws.
(h) Production costs and profits, these in turn depending upon the efficiency of management as it affects each occupation.

Each of the above factors needs to be considered in turn, in its bearing on the hourly base rate and range from minimum to maximum that should apply to each grade and class of job in each trade or occupation. The rate will have to be sufficiently high to attract desirable workers, but should not be higher than prevailing rates for the same grade and class of work in a given locality.

Having determined what should be the minimum and maximum base rate for each occupation, we are ready to proceed with the necessary investigations and standardizations preliminary to the establishment of piece rates or other incentive methods. When conditions are ready for the introduction of an incentive wage system, it remains to determine for each occupation what increment or advance over the hourly base rate should be offered as the inducement or incentive under the wage plan adopted which will spur the workers on to produce effective results. Experience has shown that unless we make it possible for the average worker to add, without undue strain and merely by the exertion of conscientious application, a considerable percentage to his base earnings, he will not so exert himself. This increment varies according to the kind of work and wage system employed between limits of approximately 20 to 100 per cent of the base rate.

GENERAL PRELIMINARIES

Before undertaking the work of rate setting or the establishment of job time standards, a certain amount of preliminary preparation is absolutely essential.

Standardization and control must be developed to such an extent as is necessary in order to make the incentive system run smoothly. This doesn't mean that these matters need to be developed to anything approaching the ideal or perfection. Most companies have already in effect a certain amount of standardization and production control. It will be well to summarize what is involved in such systems:

The starting point is the preparation of manufacturing programs based on sales demands and records of previous years.

Next comes the preparation of detailed plans of materials and plans of operations.

Plans of materials involve the establishment of stores records providing for allowances or reservations to orders, the maintenance of a perpetual stores inventory and arrangements whereby materials are delivered at the proper time to the point of first operation.

Plans of operation involve the routing of unworked and worked materials to the various operating centers in proper sequence.

Scheduling involves the application of the time element to the operations with a view to determining the balance of work hours ahead which need to be performed at each production center.

Dispatching involves the removal of interferences with schedules and seeing that they are adjusted to meet changing conditions.

It is modern practice to accompany the foregoing devices with inspection where needed and with some scheme of predetermined cost estimates, departmental budgets and check-up of actual costs and results against the predetermined ones and budgets.

It is not necessary to wait for perfection in the above matters before undertaking the installation of incentive wage plans. The advantages to be secured through these wage plans are so great that it is folly to postpone their adoption to some period when the above systems and other conditions are expected to approach rather closely to the ideal. Conditions and methods are changing so rapidly that we must make the best of such systems and installations as can be put into operation in a reasonable number of months.

SPECIFIC PRELIMINARIES

Assuming that a fundamentally correct scheme of planning and production control is already in operation or has been laid out and put into effect as a necessary pre-requisite to installing the wage-incentive plan, there remain certain very essential preliminaries definitely tied up with the matter of job time standards. These preliminaries are the following:

(a) A study of variables which must be made before and during the taking of time and motion studies.
(b) A certain amount of standardization which must be done before and during the taking of time and motion studies.
(c) Time study.
(d) Motion study.
(e) Fatigue study.
(f) Determination of allowances and increments.
(g) Demonstration and training.

STUDY OF VARIABLES

In fixing standards for the performance of work, we must take into account those variables which will always be found—some of them avoidable or correctable, and some unavoidable—with the particular view of utilizing favorable variables and correcting those which can be corrected without too great an expense factor.

The most important variables are:

1. Differences in workers, which can be corrected by transfer or training.
2. Differences in surroundings, such as light, heat, convenience, etc.
3. Differences in equipment, tools, and power transmission.
4. Differences in production methods on the same or similar work.
5. Various causes, such as weather, in the case of construction work, etc.

A general survey of variables should be made before undertaking time and motion studies. Observation and recording of further variables must continue as they come to light during the time and motion studies.

STANDARDIZATION

Having investigated such matters as departmental layout of machinery, small tool equipment, motor and belt drive, material handling, etc., such changes should be made as are immediately practical and not too expensive, with a view to the greatest possible uniformity of conditions and methods as they apply to the same or nearly similar jobs when done at different machines or in different departments.

However, the way should always be left clear for further improvement and standardization by a protective statement to insure that the company is to be entitled to participation in the benefits brought about through improvements, by the insertion of some statement similar to the following on all bonus schedules and accompanying all bonus payments:

The present rates have been arrived at by a combination of the base rate and a time allowance for doing the work.

The base rate is determined by business and industrial conditions.

The time allowance is determined by time observations under existing conditions at the production center or machine to which they apply and makes due allowance for all necessary and undividable loss or non-productive time together with an allowance range as an incentive for the average worker to do the job within the limit set.

The company guarantees that the base rates will not be changed as long as there is no radical change in general business and industrial conditions.

It guarantees that the time allowances will not be changed as long as the method described on the instruction card as applying to the specific department and production center or machine as specified on the work ticket remains in effect.

Such statement localizes every time standard and its resulting piece premium or bonus standard to a specific machine, production center and department and to existing methods and conditions, and makes every such standard and rate open to change whenever new conditions and new methods are introduced.

TIME STUDIES

Having studied the report of the variables and established such standardization as is practicable, we are ready to proceed with time

studies. These consist of the observation of operations and recording the unit times required to perform the elementary steps of these operations preferably by the use of a decimal stop watch mounted on a board to which is attached a particularly prepared time-study record blank drawn up for the kind of work to be studied and on which a list of the elementary steps to be studied has been entered through preliminary study made prior to the time-study.

Every well-conducted time-study department builds up a reference file of standard elementary times which repeat themselves. Some of these remain constant irrespective of changing weights or dimensions of material. Others, having been observed for certain dimensions and rates, can be adapted through calculation to new elements. The purpose is to have at hand a constantly growing set of observational and calculated data which can be reused in determining new job time standards without the necessity of taking extensive new and complete time studies.

The men selected to take time-studies should be able to observe minute details accurately; should be diplomatic, patient, and tactful; must be able to concentrate for long periods and must be students in the work of time- and motion-study and allied work in which field they will find ample reference material in text books, magazines, and the proceedings of technical societies, as they must carry no assumption of infallibility and must be ready to acknowledge and correct any and all mistakes.

MOTION STUDY

Motion study determines the correct motions in performing a given operation. It eliminates unnecessary motions and through observation and analysis, introduces improvements. Motion-study research will often develop machinery and other devices to several motions. Motion-study research will result in increasing manual skill on the part of the operator and the attainment of mechanical perfection in the machinery employed. Not all industries and not all time-study men are adapted to the work of motion study. On the other hand, it is of vital importance in some industries. According to Gilbreth, the elements of a cycle of motions consist of the following arranged in various sequences:

1. Search
2. Find
3. Select
4. Grasp

5. Position
6. Assemble
7. Use
8. Disassemble, or take apart
9. Inspect
10. Transport loaded
11. Prepare position for next operation
12. Release load
13. Transport empty
14. Wait (unavoidable delay)
15. Wait (avoidable delay)
16. Rest (for overcoming fatigue)

FATIGUE STUDY

Fatigue study has for its purpose the elimination of unnecessary fatigue which results not only in the work taking more time than it should, but also in needless loss to the worker. Frank Gilbreth designates unnecessary fatigue as the worst form of waste. Industrial physicians recognize that fatigue, whether due to eye-strain, due to insufficient light or to glare, due to poor ventilation, to excessive expenditure of energy or to nervous tension, results in the accumulation of poisonous wastes in the system. If these are allowed to accumulate more rapidly than they can be eliminated, they produce a deadening effect on the mind and body of the worker. The worker's condition is reflected in the quality and quantity of his work and in his mental attitude.

The solution of the fatigue problem is not found in so easy a remedy as the general mid-morning and afternoon rest period for all workers, so often recommended by superficial thinkers and writers on this subject. The solution is usually a different one for each case in which fatigue is a factor. Hence, fatigue studies must be made on those particular jobs which involve long and excessive physical or nervous strain, and the frequency and length of rest periods must be determined as applicable to the specific situation. Other contributory factors, such as poor light, glare, poor ventilation, poor material handling devices, etc., will have to be rectified.

ALLOWANCES AND INCREMENTS IN GENERAL

Ordinary allowance for human necessities is five minutes for each hour. Other allowances are such as for the time required to get started which will result in different time standards for small lots as compared with larger ones.

The probability curve, or Sine curve, applies to time-study operators as it does to runners in a race or to students taking an examination. Hence, allowances must be made on all time studies cover-

ing manual or physical operations to adjust them for inferior averages and superior operators, even when all are working under the same conditions otherwise. This consideration results in a so-called allowance to adapt the time study to the average operator.

After having determined on the preceding three allowances, namely,

1. Human necessities
2. Fatigue
3. Adaptation to the average operator

it is customary to add an increment for incentives in all those wage-plans where the reward is based on doing the work in less time than a specified one. This increment varies from 20 to 100 per cent of the time-study elements, plus the above three allowances.

DEMONSTRATION AND TRAINING

Before putting the wage plan into effect on any job, an essential factor is the necessary training and demonstration. This is of two kinds, namely,

(a) Training of the operators
(b) Training of the supervisory and demonstration forces

The training of the operators consists of putting them under the direction of a superior operator, generally one who has been used as the subject for the time studies on the job or a class of work similar to that involved. This superior operator is usually given a bonus of 20 per cent over his base rate as extra compensation while he is demonstrating or teaching. It is customary to give him also this bonus while he is being time-studied. It is up to the demonstrator to see that the new operator uses the machine adjustments for kind of material, dimensions, depth of cut, etc., which have been decided on as standards. He will then see that the operations are performed in the sequences and within the time agreed on. The demonstrator will correct, as far as possible, the learner's motions where they need corrections.

This demonstration period is the time for making any corrections of errors in the time-study and instruction card. If the learner should be fortunate enough to do the job within the prescribed time standard, he should be compensated at once on the basis of the incentive system. It is not essential, and often not practicable, for

the time-study man to be present during the entire period of demonstration and teaching as he is likely to be away on other time studies. If any question arises which requires the time study man's presence, the demonstrator will get into touch with him.

In the matter of training the supervisory and administrative force, it is important that conferences be held during working hours in the course of which each step in the entire program is explained and discussed in such a manner that every supervisor and every person connected in any manner with the operation and administration of the plan not only understands it but is 100 per cent sold on the desirability of the system and making it work. These men should be made to understand that the company depends on them to cooperate in putting the plan across, and that nothing could be worse than to have derogatory remarks or even mental reservations on their part.

GUARANTEE AGAINST CHANGES

Progressive companies try to make their workers feel that whatever success comes to their business for which any department or any individual in a department is entitled to credit by reason of their contribution in having helped to develop it, they will be compensated financially in addition to verbal commendations. They believe that this procedure has worked towards the development of mutual confidence and helps to establish employes' feeling of relationship toward the organization they are a part of.

Unusual earnings of workers are likely to produce jealousy on the part of other workers, as well as to excite the cupidity of a certain type of company official who have not the inclination nor ability to understand the underlying principles of management science and philosophy on which they are based. Excessive earnings can and should be avoided against by proper preliminary studies. However, unusual effort and teamwork resulting in as high earnings as double the base rate, should not be a matter of concern by a progressive management so long as unit costs to the company are being lowered and corresponding profits earned. It does not take a group of experienced workers long to determine how much they will be allowed to earn over and above their regular base rates without having to expect further analyses and new time studies, or new methods as a substitute for the old fashioned rate cutting. Under such circumstances, the employes will revert to what Taylor called "systematic

soldiering," a result which must be expected if company policy is to limit or cut down the employe's share in the profit or savings.

As a result of extensive experience in installing wage-incentive systems and as a result of careful assembly of the opinions of the highest authorities on this subject, the author and compiler of this volume said the following in the fourth edition of his book on *Factory Organization and Administration:*

Rates must be carefully and correctly fixed at the outset on a basis of time- and motion-studies and even if they cause high earnings must not be cut. Cutting rates inevitably causes disloyalty and hostility of employes.

It is only where there is a real difference in equipment and method where such changes are justified.

When existing rates are the results of careful study and are working satisfactorily, so long as unit costs do not rise and are kept at an effectively low figure, employers should be happy and congratulate themselves if they are able to pay higher wages coupled with lower costs.

Every once in a while some reactionary or uninformed official of some company who belongs to a trade association when he receives data as to the average hourly earnings of men in some occupation, say founders or machinists, and finds that his own company which is on an incentive plan is paying considerably more than this average, is moved by cupidity to order his superintendent or personnel man or whoever is in charge of rates to cut down the rates so that his employes are not getting more than the average in the trade. The result is always disastrous because the result is that usually the superintendent or industrial relations manager begins looking around for a new job. The men in the ranks become dissatisfied and it does not take long until, as a result of the disorganization, unit costs begin to rise tremendously.

PAY-ROLL STATISTICS AND COST RECORDS

All these arrangements for controlling work and trained workers and securing production would be incomplete unless we have a prompt and reliable record of accomplishment and a means of measuring this by achievement in earnings. So we must have a pay-roll organization who not only figure the earnings of each worker or group of workers, but who collect the items of pay in its component

parts so that we may judge the accomplishment in each of the details that the method of pay is designed to compensate.

Every worker or group of workers is entitled to know promptly just what the earnings have been in each of the items for which a standard should be attained and the foreman must also know this as well as the names of those who are falling below "minimum." If people are properly instructed and supervised and still fail to reach standard it is more than likely that they are not suited to the kind of work they are doing and should have opportunity offered on a different kind of job. Many a worker who was an apparent failure on one job has been successful when shifted to other work for which he was better qualified, and it is the responsibility of management to keep both the foreman and the operative constantly advised as to the latter's accomplishment so that help and instruction may be promptly given when needed.

Finally, all records of output and earnings must be collected and arranged so that the results can be measured finally in terms of cost, and exact information given as to just what results have been achieved.

From the foregoing discussion, it is obvious that in order to make any system of wage payment effective we must have in connection with it, provision for scheduling, materials control, job classification, base rates, study of variables, standardization, time and motion studies, fatigue studies, allowances, demonstration and training; pay-roll statistics and costs. These are so interdependent that while each one is of isolated value it has potentially much greater profit possibilities insofar as it coordinates with all the others.

PART II

DESCRIPTION OF THE FUNDAMENTAL AND BEST KNOWN PLANS

II

DIFFERENTIAL PIECE RATE

THIS plan was established by Frederick W. Taylor, at the Midvale Steel Company, Philadelphia, in 1884. This system consists of two rates: the first, or standard rate, sometimes called Below Task Rate, and the second, the higher rate, sometimes called the Above Task Rate. The higher rate may be 30 to 50 per cent higher than the low rate. The lower rate applies until the quota for a given period is reached, called "task," when the higher rate takes effect. This quota for a given time or task, is based on time-study. To illustrate: if standard production is set at 25 pieces a day and a piece rate of 17c a piece is established, a high piece rate might be established at 22c a piece. If the worker produces 24 pieces he will receive $4.08 for the day, but if his production is 25 pieces his day's pay will be $5.50.

The plan is designed to do away with the inefficient worker who cannot meet the conditions by penalizing him with low pay, while it aims to pay the successful worker, who does meet the conditions, a wage-rate proportional to the results he gets.

The differential piece-rate system obviates the disadvantage of a straight piece-rate inasmuch as it does away with the fear that if production is increased, rates will be cut. The differential piece rate proves at once that the employer not only has no intention of cutting rates, but is actually paying a higher rate if a certain amount of work is produced.

This would seem to make the work done by the expert workers cost more than that done by slower men, but the opposite is true when the machine-time burden is taken into consideration.

The company can afford to offer the increased piece price, because the cost of operating a machine tool, including power, light, heat, rental for floor space, tools, oiling, repairs, etc., is often greater than the rate of the mechanic who is operating the machine. The day rate of a machine remains very nearly stationary no matter what its output. It therefore pays to drive machines to their capacity.

This last point may be illustrated mathematically: Let us assume

that the cost of operating the machine is 70 cents an hour. The formula for determining the direct-labor and machine cost per piece will be:

$$\frac{\text{Machine rate} \times \text{hours} + \text{piece rate} \times \text{number of pieces}}{\text{Number of pieces}} = \text{cost per piece}$$

If a poor workman turns out eleven pieces, the cost per piece will be:

$$\frac{70 \times 8 + 60 \times 11}{11} = \$1.11$$

In the first case the workman earns $4 a day, while the second workman with his higher piece rate earns $6.60 a day. This illustration shows how both employer and employe may profit under a properly adjusted wage system of this kind.

ORIGINAL HALSEY PLAN

The Halsey plan provides for fractions, usually a third to a half of the time saved to be paid to the worker at his wage rate. The percentage of the time saved is decided upon as the conditions may warrant.

The standard time is determined from previous experience, the average of the previous times being taken rather than that from a detailed and scientific time study.

The Halsey plan guarantees a day rate, and permits a compensation in addition to the regular amount given an operator for length of service or greater worth.

There are many instances in which the standard time set under this system has been found to be three or more times as long as necessary. Because of this it was believed by Mr. Halsey that a 50 per cent bonus on a difficult job on which time had been carefully set is fair, while the 33⅓ per cent may be sufficient where the standard has been roughly determined.

The method of figuring wages under the Halsey premium system is expressed in the following equation:

$$\text{Wages} = \text{time taken} \times \text{the hourly rate} + \text{the time saved} \times \text{a fraction of the hourly rate}$$

The advantages of the Halsey plan are several. In the first place, it is very simple, and not as confusing to the workmen as other plans

where it is almost impossible to figure out the amount of the weekly pay envelope. When the worker knows the standard time and the actual time it took him to do a job, it is easy for him to subtract the actual from the standard and then multiply the remainder by 30 or 50 per cent (or whatever is the amount of his hourly rate).

The Halsey plan has been criticized from several angles. Employes think it unfair to receive payment for only a part of the time saved when they believe that the time saved is due fully to their efforts and not to those of the employer. They lose sight of the fact, however, that standards set without scientific study are bound to be very liberal.

HALSEY PLAN WITH TIME-STUDIED STANDARDS

The gain sharing features of the original Halsey scale have been retained in many recent introductions of the premium system in which, however, standardization, classification, and time studies accompany the establishment of the standard time instead of the old idea of past average time. This makes virtually a new system. Under these circumstances, a time standard based on time studies will have to have an increment added as an incentive to time reduction. This increment is usually 40 to 100 per cent of the minimum high-efficiency time.

THE ROWAN PLAN

This is a modification of Halsey's premium system, devised by Mr. James Rowan, a member of a well-known Scotch engine establishment. Time limits are established as under the Halsey system. The amount to be added, in case the time limit is reduced, is figured in the following manner: The premium equals the money value of the time actually taken to do the job, multiplied by the time saved and divided by the time limit. For example, if the time limit is 10 hours for a piece of work on which is employed a man receiving 30 cents an hour, and he does the work in 8 hours, then his pay will be 8 times 30, or $2.40, for his regular time; the premium to be added will be $\frac{2 \times 2.40}{10}$ or 48 cents.

Further results of the application of the Rowan Plan are exemplified in the following table:

Time Allowed	Time Taken	Wages on job at 30c an hour	Premium money value x per cent of time saved	Workman's earnings per hour	Total labor cost of job
10 hours	10 hours	$3.00	0	.30	$3.00
10 hours	9 hours	2.70	.27	.33	2.97
10 hours	8 hours	2.40	.48	.36	2.88
10 hours	7 hours	2.10	.63	.39	2.73
10 hours	6 hours	1.80	.72	.42	2.52
10 hours	5 hours	1.50	.75	.45	2.25
10 hours	4 hours	1.20	.72	.48	1.92
10 hours	3 hours	.90	.63	.51	1.53
10 hours	2½ hours	.75	.56	.52	1.31

An investigation of this table, as well as the trying out of actual figures in the formula given, will show that, no matter how far the time is reduced, the premium will never be quite as great as the regular pay at a given time, so that the man can never double his wages under this system. As soon as the work is done in less than half the standard time the premium becomes less.

The Rowan system is used to a considerable extent in Great Britain. Objections have been made to it on the ground that there ought to be no limit to the amount of premium or bonus which a man can earn. In reply to this the statement is made that the management may have a very definite idea of the shortest time in which it is desirable to do the work, considering accuracy, wear of machinery, and fatigue affecting the man. Another objection to the system is that it requires a higher grade of clerical help to figure out the premium than is needed with the Halsey system, also that figuring the premium is too complicated an affair for the workman, and that he will therefore become dissatisfied. Where the clerical labor and the mechanics are both of a high order of intelligence, these last objections will not hold good. There are conditions, however, under which they will be valid.

GANTT BONUS SYSTEM

The severity of the Taylor Differential system was modified by Gantt, as fully described in his book *Work, Wages and Profits.* Gantt felt that there must be an incentive to the average worker.

Task-work-with-a-bonus-system was introduced by Gantt in 1901 at the Bethlehem Steel Works. When Gantt first started this system, the worker was paid by the time taken for completion of the job instead of by the piece. For instance, if the time allowance for a job was four hours, and the worker did it in three hours, he received four hours' pay, but in order to get the bonus pay he must do all the day's jobs within the bonus time, otherwise he reverted to his basic day rate.

Gantt modified this original plan which started incentive reward only when the job was accomplished in the designated standard time, by a later plan under which the bonus instead of starting when the standard, or 100 per cent efficiency is attained, starts at 66.6 per cent efficiency, thereby rewarding the effort to attain the standard as well as paying high bonus for high efficiency.

The workers are paid a minimum hourly rate up to 66.6 per cent efficiency on the task when the rate is increased at an increasing bonus rate usually starting at 10 per cent and reaching 30 per cent for doing the job in task time or less. Thus the later development of Gantt's plan recognizes the possibility of doing work in less time than the job standards as set and offers reward for such accomplishment.

The method of figuring is not explained to the workers, but tables with times and corresponding bonuses for each job are posted, such tables beginning with the time corresponding to 66.6 per cent efficiency, when bonus begins, and ending with standard and a scale as to bonus on the job when done in less than job standard times.

Another feature of the Gantt system is the paying of a bonus to the foreman for each man under him who makes a bonus, and a further bonus if all the men make a bonus. Thus, if the foreman had ten men under him and nine made a bonus, he would receive 10 cents for each of these men, making 90 cents extra each day; but if the entire ten made a bonus he would receive 15 cents for each man, or $1.50 per day. Mr. Gantt claimed that this plan was the first recorded attempt to make it to the financial interest of the foreman to teach the individual worker. "Under former conditions," said Mr. Gantt, "the foreman hesitated to teach the workmen for fear the latter might learn as much as he knew and possibly get his job. Under the new condition the man who knows is paid for teaching others as much as he knows, and the others are paid a bonus for learning and doing what they are taught. It is the feature of the task and bonus system that has enabled us not only to attain, but to maintain permanently such satisfactory results. The expert

workman who becomes a good assistant makes his services valuable, for by his assistance we can often make the average efficiency of the shop even greater than its best efficiency was before we began to study the questions of efficiency. He learns to remove obstacles which stood in his way when he was simply a workman, and often becomes an expert also, not only at removing these obstacles, but at developing better methods to avoid them."

DIEMER BONUS AND PREMIUM SYSTEM

The writer introduced in 1905 at the Atlas Engine Works at Indianapolis a system in which the workmen were paid a 10 per cent increase of their wages if they reduced below past average the time in which the work was done. They were paid 20 per cent of hourly wage increase if the work was done in a specified standard time, such standard time being based on motion- and time-study, on demonstration by skilled mechanics, and about 30 per cent being added to this time. A further so-called "gain sharing bonus," on the Halsey premium plan was allowed if they did the work in less than the specified standard time. In addition to the bonus wages paid, a record was kept of every man's percentage of success during each pay period, and each man's percentage of success under the system was made the basis of promotion in his hourly rate.

The field for this system is the same as that for the bonus system. Its particular advantage lies in the fact that, recognizing the tendency of men to work in spurts on certain jobs, it offers inducements to men who are faithful and steady in their efforts to do every job in the standard time. This system was described in the *Engineering Magazine* for August, 1905.

EMERSON EFFICIENCY SYSTEM

In this system a standard time is established for each job. During each pay period a record is made of the number of hours a man worked on the jobs on which time standards were established. Then the total hours in which he did these standard time jobs is divided into the total sum of the time standards. For example, if the sum of the standard times in a given pay period aggregates 210 hours, and the man took 240 hours on these jobs, then his efficiency would be $\frac{210}{240}$, or 87.5 per cent.

Mr. Harrington Emerson devised a sliding-scale for determining the bonus to be paid under the efficiency system. This scale is as follows:

EFFICIENCY BONUS PER $1 WAGES

67	.0001	73	.0075	79	.0280	85	.0623
68	.0004	74	.0101	80	.0330	86	.0693
69	.0010	75	.0131	81	.0380	87	.0763
70	.0020	76	.0161	82	.0435	88	.0840
71	.0035	77	.0199	83	.0495	89	.0920
72	.0055	78	.0238	84	.0555	90	.1000

Above 90 per cent efficiency add the percentage above 90 to 10 per cent and the sum is the fraction of wages to be paid as bonus.

In the minds of men technically trained as engineers, there arises some confusion in regard to the use of the term "efficiency." We all know that the word "efficiency" as used by engineers, is the ratio of actual results to ideal performance, or in other words, the ratio of output of work to input of energy. In efficiency wage-systems the ratio for efficiency is apparently reversed from that used in science and engineering. If, by time study, it is shown that a worker should do a certain task in five hours and he spends six hours on it, his efficiency must be the ratio of standard or ideal performance to actual results. The use of the word "efficiency" as it has been adopted into the terminology of management science must be clearly understood.

One of the features of the Emerson system is that the bonus is not ordinarily paid for each task by itself, but is arranged for certain periods, as a week or a month. This has the advantage of sustaining the effort of the worker. He cannot speed on one job and let down on another. This continual effort, Mr. Emerson believes to be necessary to efficiency. Under this system overtime is discouraged. The Emerson system has in it more the idea of bringing the men up to a standard by persistent effort, patient instruction, and growing reward rather than that of calling for native capacity as under the Taylor system. The division line between satisfactory and unsatisfactory performance is not as marked, although the incentive for better work is still there.

THE BEDAUX PLAN

The Bedaux point system is based on calculations representing the quantity of work which should be done in one minute, due allow-

ance having been made in the calculation of the point, for rest and unavoidable delay. Standard production consists of 480 points per 8 hour day. A "standard" under this system is the number of minutes or fraction of a minute allowed to perform each operation. For a given performance or job the number of points produced is calculated by multiplying the "standard" for the operation by the number of pieces completed. In the case of an 8 hour day a worker whose record of jobs completed that day runs over 480 points, is credited with a bonus of 75 per cent of the value of these points, this value being established on the basis of the money saved the company through accomplishing the work in the standard time. The other 25 per cent of the value of the points is turned into a pool which is distributed periodically among foremen, time-study men, bonus-clerks and other indirect workers, as their share in increasing the production. In order to know how much bonus he has earned in the course of the day, the workman has only to total the number of points allowed on the jobs which he has completed during the day, deduct the standard number of points from the total, and multiply the result by the value of his point. If at the end of the day he has completed all of the work assigned to him and the total of the allowed points is 540, then he has earned a premium of 60 points. If his hourly rate is 60 cents an hour, the value of his point is 1 cent. Therefore his premium is 60 cents.

When the employee receives the full value of the allowed points, the plan is really a special application of the principle of the Halsey premium plan in which the employee receives 100 per cent of any savings of the allowed time. Below standard the time wage is guaranteed. Here, the standard minute of work is termed Bedeaux, or "B," with 60 B's to the hour of standard work. It is claimed that this plan is well adapted to the measurement of efficiency between departments and plants. The usual variation is from 60 to 120 with very few making 100 B's per hour. Time-study men skilled in rating workers acquire a pretty fair idea of normal speed, and after some practice are able to very accurately determine the rate of speed of any operator.

THE HAYNES MANIT SYSTEM

The Haynes Manit System is a plan of wage payment and production control, including labor and supervision measurement and incentives.

In its latest form (since January 1928), the principles of piecework have replaced the principles of standard time and bonus. All production is converted into Manits, or standard man-minutes of work. A standard number of Manits is established by time-studies, graded to normal efficiency, for each operation. Under conditions of non-repetitive work, tables of standards are established covering maximum to minimum variations of each operation.

Each productive worker is given a wage rate per hundred Manits, according to his occupation. The Manit wage rate corresponds to a piece rate, except that it applies to all operations covered by Manit standards. The worker's pay is directly determined by the number of Manits he produces. His rate per hundred Manits depends upon his class of work, his former earnings and efficiency, and his length of service. The direct worker may or may not be guaranteed a minimum hourly wage for each day's work, according to conditions.

The Manit is four-fifths of the full amount of work that the normal average worker can do in a minute of time, throughout his day's work, without over-exertion; it is irrespective of the nature of the task and is determined from time-study analyses. The standard rate of production is 60 Manits per hour, and the normal ultimate rate of production is 75 Manits per hour. The Manit rating of a worker is his efficiency index; it is comparable with that of each and every other Manit worker, regardless of occupation or work done.

At 75 Manits per hour, the worker earns 25% more than at the standard rate of production. His rate of pay per unit of production is constant, and does not increase or decrease with his volume, his total earnings are, therefore, directly proportionate to his total production. According to conditions, the worker may or may not be paid an hourly wage during delays. He is always guaranteed an hourly wage for work he does which is not covered by Manit standards.

The efficiency of supervision and indirect labor is measured by a supervision Manit rating for each department. The supervision rating is the combined Manit-per-hour rating of the productive workers, modified by the ratio of the budgeted non-standard hours to the actual non-standard hours of the department.

The non-standard hours of a department are the supervision and indirect labor hours, the waiting hours of productive workers, and the hours spent by productive workers on work not covered by

Manit standards. Hence the supervision rating is the combined efficiency index of the department as a whole, including the accomplishments of both productive and non-productive workers.

Bonuses are paid to supervision and indirect labor, over and above their regular salaries and wages, according to the supervision ratings of the departments and the relative importance of the individual. The total amount of bonus paid supervision and indirect labor is limited to 4½% of the combined earnings of the direct workers who produce individually at a daily rate in excess of the standard of 60 Manits per hour; but such bonus is not deducted from, nor taken out of, the earnings of the direct workers.

The total payroll cost per hundred Manits of work produced by a department is the labor cost index of that department, which can readily be compared with the department's standard labor cost (at 60 Manits per hour). As the Manit is a common unit of production, inter-departmental labor cost comparisons are always available; and payroll savings resulting from the installation of the System, after deducting all clerical costs of operating the System, are definitely determined.

No credit in Manits is allowed for poor work. Where conditions permit, quality standards are established and variations above and below such standards are computed in Manits as credits or debits in calculating the pay of workers and supervisors.

Production control is facilitated by the recording of waiting time, and its reduction through incentives; and by the fact that all output is measured in Manits, the number of employes required for a particular volume can be accurately calculated in advance. In the same manner, labor cost estimates for the making of accurate quotations are forecasted.

Under all operating conditions, including those which are highly diversified, the productive worker can readily calculate his own earnings under the Haynes Manit System, as all of his production is computed and expressed in Manits, and his wage rate also is based on Manits.

GROUP INCENTIVE PLANS

THE YALE AND TOWNE PLAN

THE recent growth and development of group incentive systems in automotive trades during recent years might seem to indicate that the group method of applying incentives is a comparatively

recent institution. It is a matter of record, however, that in May, 1889, Henry R. Towne, in a paper entitled "Gain Sharing" before the American Society of Mechanical Engineers, described a group bonus system as used in his company's plant. In that paper Mr. Towne made the following statement: "Webster defines profit as excess of value over cost, and gain as that which is obtained as an advantage. I have availed of this well-expressed though delicate distinction between the two terms, to coin a name for the system herein described, whereby to differentiate it from profit-sharing as ordinarily understood and practiced. The right solution of this problem will manifestly consist in allotting to each member of the organization an interest in that portion of the profit fund which is or may be affected by his individual efforts or skill, and in protecting this interest against diminution resulting from the errors of others or other extraneous causes not under his control. Such a solution, while not simple, is attainable under many circumstances, and attainable by methods which experience has shown to be both practical and successful."

The plan advocated by Mr. Towne is the differentiating of all items affecting cost of production over which the operatives have no control whatever, and offering the operatives a share, say one-half, of any reduction per unit of product that they may be able to bring about in these items in the course of a year. Foremen and other responsible heads are to receive a larger pro rata share of the saving effected than the rank and file.

Mr. Towne presented tables showing the operation of the system for two years at the Yale and Towne Works.

AUTOMOTIVE INDUSTRY DEVELOPS GROUP SYSTEMS

Notwithstanding the priority of Mr. Towne's plan to those by Halsey, Taylor, and Gantt, individual effort plans of incentive reward were the only ones in general use until the automotive industry developed group systems of efficiency reward.

In automobile factories and most accessory plants, the character of product is such as to make parts move progressively from one operation to the next to a very great extent. Processes have been standardized and divided into minute detail and, being of such repetitive nature, operations have been segregated into progressive flow-lines wherever possible. This was a natural result from the

desire to minimize the expense and delays incident to transporting materials in process. The consequent physical arrangement of these factories has had an important bearing on wage-incentive problems.

It must be taken into account that an individual-effort system of payment to workers entails considerable routine expense.

In most of the automobile companies' plans a standard time is established for each part or assembly on which work is done. Each day the scheduled production of that part or group is multiplied by the standard time. This gives the group standard hours for the total number of pieces or assemblies for the day's schedule.

Each day the work tickets of each employee are charged against the groups or parts worked on. If the standard hours on a group was 1,200, and the actual hours from various employees' work cards showed 1,000, then the efficiency was 120 per cent, and each employee is given a percentage of increase over his hourly pay for work done on that group, based on a scale similar to the Emerson scale.

In this case, it would amount to 40 per cent. This system simplifies the wage accounting as a part may have twenty distinct operations, all of which to be sure have been carefully time studied before the establishment of the standard time on the part. But the aim of meeting scheduled production is furthered far more effectively by the group bonus than it would be by any individual operation incentive.

The following main principles of operation are associated with this plan:

(1) Job tickets or production boards are not required for group work.
(2) All work flowing through a division must be entirely covered with standard time for each group.
(3) A group cannot be both on standard time and day work, because there are no job tickets for group work.
(4) If an individual is assigned to do work foreign to the group, he must be transferred out of the group, to the individual system; and he must obtain a job ticket, in order that his time can be distributed and costs computed.
(5) All bonus earned by a group is directly absorbed in the cost of operation of the group, by being included in the total wages paid.

PACKARD MOTOR CAR COMPANY GROUP SYSTEM

In this plan, record is kept of the output by groups, and not by individuals. Count is kept only of the number of finished complete parts, no attempt being made to keep track of operations. Quality

is insured by the work of the inspection department which is entirely independent of the wage payment plan, the reason for this being that there is always a tendency to slight the work when the workmen are engaged in an incentive plan.

The standards for each piece are established through standard operation times set as the result of time standards. From these the standards for charts and departments are built up. Deviations from the standard are reported by means of time tickets, these tickets being the only ones used in productive departments, excepting where other than standard or incentive plan work is being done, in which case the time ticket gives all the necessary information for obtaining costs.

The time value of the completed product as reported by the inspection department is computed daily and summarized by each pay period. By comparing the standard time of all of the work turned out each day and each pay period with the actual time taken by the workmen in the group to turn out the work, a report is obtained by the work turned out and time taken to turn it out.

The company pays one per cent bonus of regular wages for each per cent that is above regular time or which exceeds a predetermined point during the entire pay period. This predetermined point varies from 70 to 80 per cent efficiency depending on the kind of work done in each group. As the average efficiency attained under the plan is approximately 90 per cent, the bonus earned varies from 10 to 20 per cent and higher.

Cost control is secured through the fact that as standard efficiency is reached, the cost is practically constant so that the company knows that if an efficiency in excess of the predetermined one is maintained, the costs are all below standard.

HUDSON MOTOR CAR COMPANY GROUP SYSTEM

In this plan the men are guaranteed their day rate and in addition are paid a bonus made up from a claim made up from the number of pieces produced. The claim of the number of pieces is based on the number of completely assembled groups turned out. For instance, the men in the Axle Department groups are paid the regular daily rate plus a bonus dependent on the number of complete axles produced in the department. No attempt is made to count individual pieces or any particular operation. The standards estab-

Percentage		Percentage		Percentage	
Efficiency	Bonus	Efficiency	Bonus	Efficiency	Bonus
75	1.0	117	40.4	159	90.8
76	1.6	118	41.6	160	92.0
77	2.2	119	42.8	161	93.2
78	2.8	120	44.0	162	94.4
79	3.4	121	45.2	163	95.6
80	4.0	122	46.4	164	96.8
81	4.6	123	47.6	165	98.0
82	5.2	124	48.8	166	99.2
83	5.8	125	50.0	167	100.4
84	6.4	126	51.2	168	101.6
85	7.0	127	52.4	169	102.8
86	7.6	128	53.6	170	104.0
87	8.2	129	54.8	171	105.2
88	8.8	130	56.0	172	106.4
89	9.4	131	57.2	173	107.6
90	10.0	132	58.4	174	108.8
91	11.0	133	59.6	175	110.0
92	12.0	134	60.8	176	111.2
93	13.0	135	62.0	177	112.4
94	14.0	136	63.2	178	113.6
95	15.0	137	64.4	179	114.8
96	16.0	138	65.6	180	116.0
97	17.0	139	66.8	181	117.2
98	18.0	140	68.0	182	118.4
99	19.0	141	69.2	183	119.6
100	20.0	142	70.4	184	120.8
101	21.2	143	71.6	185	122.0
102	22.4	144	72.8	186	123.2
103	23.6	145	74.0	187	124.4
104	24.8	146	75.2	188	125.6
105	26.0	147	76.4	189	126.8
106	27.2	148	77.6	190	128.0
107	28.4	149	78.8	191	129.2
108	29.6	150	80.0	192	130.4
109	30.8	151	81.2	193	131.6
110	32.0	152	82.4	194	132.8
111	33.2	153	83.6	195	134.0
112	34.4	154	84.8	196	135.2
113	35.6	155	86.0	197	136.4
114	36.8	156	87.2	198	137.6
115	38.0	157	88.4	199	138.8
116	39.2	158	89.6	200	140.0

Bonus Table for Productive Workers

lished are based on time standards from which unit times and group times are predetermined. Deviations from these standards are reported when gangs fail on a production basis to earn as much as

the guaranteed daily rates, this condition being a signal for investigation and check up.

GENERAL MOTORS GROUP SYSTEM

In a pamphlet outlining this system the company says:

(1) Under any incentive plan, the worker must continue to maintain an individual interest in the rate of production
(2) He should be guaranteed a satisfactory hourly wage
(3) He should be paid for all time saved instead of for only a part of it
(4) He should be able to compute his own earnings accurately and quickly

Under the group plan, it would not make much difference in theory whether a fixed group-price were established or some form of bonus or premium payment were used. Our past experience, however, indicated that it was preferable to set standards of output in *time* rather than in money value. With changing labor scales, we should then have no disturbance of the existing time-standards, but would make the adjustments on the hourly-base wage-rates on which bonus earnings are computed. Time standards also have the advantage of a very flexible wage-rate, by which means new employees can enter our service at a minimum rate subject to advancement through length of service and personal ability. Such revision in wage rates can be made at any time without in the least disturbing shop standards or affecting other employees.

On the other hand, a fixed group-price in money-value would offer some very definite objections if adopted as a general plan, since the

(1) Division of the earnings among the group members would have to be on an even basis per hour worked; or
(2) Group earnings would have to be pro-rated on the basis of the hours worked by the individuals, multiplied by the predetermined base-rates. A change in an individual base-rate would affect all other members of the group, or the transfer of an employee with a different base-rate would upset their relative earnings.

In regard to a uniform base-rate for all members of a group and their division of the earnings purely on an hourly basis, it is obvious that this method would prove unsatisfactory as a general policy; because, in the same group, some operations may require more skill than others. Then there is the added consideration that employees who have been long in the service should be on a higher wage plane than beginners. The standard-time bonus table as adopted offers every facility for differentiating between base-rates

Min.	Equivalent Hours	Rate of Production per Hour	Min.	Equivalent Hours	Rate of Production per Hour	Min.	Equivalent Hours	Rate of Production per Hour
0.01	0.000167	6000.0	0.34	0.00567	176.5	0.68	.001133	88.2
0.02	0.000333	3000.0	0.35	0.00583	171.4	0.69	0.01150	87.0
0.03	0.000500	2000.0	0.36	0.00600	166.7	0.70	0.01167	85.7
0.04	0.000667	1500.0	0.37	0.00617	162.2	0.71	0.01183	84.5
0.05	0.000833	1200.0	0.38	0.00633	157.9	0.72	0.01200	83.3
0.06	0.001000	1000.0	0.39	0.00650	153.8	0.73	0.01217	82.2
0.07	0.001167	857.1	0.40	0.00667	150.0	0.74	0.01233	81.1
0.08	0.001333	750.0	0.41	0.00683	146.3	0.75	0.01250	80.0
0.09	0.001500	666.7	0.42	0.00700	142.9	0.76	0.01267	78.9
0.10	0.001670	600.0	0.43	0.00717	139.5	0.77	0.01283	77.9
0.11	0.001830	545.5	0.44	0.00733	136.4	0.78	0.01300	76.9
0.12	0.002000	500.0	0.45	0.00750	133.3	0.79	0.01317	75.9
0.13	0.002170	461.5	0.46	0.00767	130.4	0.80	0.01333	75.0
0.14	0.002330	428.6	0.47	0.00783	127.7	0.81	0.01350	74.1
0.15	0.002500	400.0	0.48	0.00800	125.0	0.82	0.01367	73.2
0.16	0.002670	375.0	0.49	0.00817	122.5	0.83	0.01383	72.3
0.17	0.002830	352.9	0.50	0.00833	120.0	0.84	0.01400	71.4
0.18	0.003000	333.3	0.51	0.00850	117.6	0.85	0.01417	70.6
0.19	0.003170	315.8	0.52	0.00867	115.4	0.86	0.01433	69.8
0.20	0.003330	300.0	0.53	0.00883	113.2	0.87	0.01450	69.0
0.21	0.003500	285.7	0.54	0.00900	111.1	0.88	0.01467	68.2
0.22	0.003670	272.7	0.55	0.00917	109.1	0.89	0.01483	67.4
0.23	0.003830	260.9	0.56	0.00933	107.1	0.90	0.01500	66.7
0.24	0.004000	250.0	0.57	0.00950	105.3	0.91	0.01517	65.9
0.25	0.004170	240.0	0.58	0.00967	103.4	0.92	0.01533	65.2
0.26	0.004330	230.8	0.59	0.00983	101.7	0.93	0.01550	64.5
0.27	0.004500	222.2	0.60	0.01000	100.0	0.94	0.01567	63.8
0.28	0.004670	214.3	0.61	0.01017	98.4	0.95	0.01583	63.2
0.29	0.004830	206.9	0.62	0.01033	96.8	0.96	0.01600	62.5
0.30	0.005000	200.0	0.63	0.01050	95.2	0.97	0.01617	61.8
0.31	0.005170	193.5	0.64	0.01067	93.8	0.98	0.01633	61.2
0.32	0.005330	187.5	0.65	0.01083	92.3	0.99	0.01650	60.6
0.33	0.005500	181.8	0.66	0.01100	90 9	1.00	0.01667	60.0
			0.67	0.01117	89 6			

Equivalents of Minutes in Decimal Hours

and permits a flexible system to suit the varying labor and factory conditions.

The bonus table is based on the theory that a bonus incentive of 20 per cent should be paid to a worker, in addition to his hourly

base-rate, for attaining an efficiency of production of 100 per cent; and that, for a greater speed of production, he should be paid for all time saved. The table is constructed so as to give a gradually disappearing percentage of bonus, as efficiency of production falls below the standard. During the past 11 years, this bonus table has been used extensively in our plants; first as an individual-effort incentive and, in later years, as a group incentive.

The standard time of a single operation is determined by time-study. For this purpose the decimal stop-watch is used. By standard time is meant the time required by the average competent workman, taken repeatedly, over an extended period, eliminating lost and waste time. It will contain allowances for legitimate tool-changes and for rest and delay to the worker. It is our practice, for convenience, to designate standard time in decimal hours rather than in minutes. For this purpose a conversion table has been devised and is presented, because the detail time-study is observed in decimal minutes, while the standard time is converted into hours.

Group standard-time is obtained by totalling the individual standard-time for all operations embraced by a group. It thus always appears as one-man hours, independently of how many workers may subsequently be assigned to a designated group.

To obtain a clear idea of the application of group standard-time and its use as a basis for a wage-incentive plan, let us consider a single production line manufacturing and assembling pistons in an automobile-engine plant. This unit has its operations arranged in sequence, in what is known as a progressive line of manufacture. It starts with the rough-machining of the casting and ends with the finished product with piston-rings inserted. The production line includes both machine and bench-assembly operations. Parts move without a break from one operation to the next in a steady flow. Some operations may be done by a single workman; others may have several workers in parallel, depending on the volume of production and with what detail it is practicable to subdivide operations.

It is proposed to keep no check on quantities passing intermediate operations, or on those completed by individual workers on operations in parallel, but to give credit for finished pistons passing final inspection. This particular production line may be located in a department also producing connecting-rods or any other line of manufacture. Such a line embraces a production unit of the fac-

tory, and is technically known under the group plan as a *division*. Its workers are primarily interested in the production of pistons; they know little or nothing about conditions on the connecting-rod line and should not be grouped with it.

A study of the piston-line division indicates that there are two distinct classes of machine work, besides bench operations. The machine operations are lathe turning and grinding. There are thus three major operations, and the workers group themselves naturally into these three classes of work. It is thus seen that a division may consist of any number of distinct groups. They are bound together because they receive credit only for the finished product at the end of the division, while they are distinct and independent so far as efficiency measurement and bonus reward are concerned. A group is debited with the actual man-hours of the workers in the group and is credited with the group standard-hours multiplied by the number of pieces passing the division. That is, the quantity count is not taken at the group operations but at the end of the division of work. The ratio between standard hours and actual hours constitutes the efficiency measurement for which a bonus percentage is paid. For convenience, the entire pay period of 1 or 2 weeks is run on a cumulative basis, and bonus is computed on the average efficiency attained for the period. Obviously, for a given product, the fewer actual man-hours there are in a group, the higher the efficiency of production will be and the greater the per cent of bonus earnings. The incentive is, therefore, to obtain a high rate of production per man per hour consistent with good quality of product.

Each member of a group receives the same percentage of bonus at the end of the pay period, but it is computed on his wage earned while assigned to the group; and the total amount earned by each worker will, therefore, depend on his hourly base-rate and number of hours worked. No job tickets are used. A shop timekeeper will handle from 300 to as high as 600 group workers. A list of employees is tabulated daily for each group, and elapsed time is taken at the end of the day from the entrance time-clock. If a worker is transferred out of or into a group, a transfer slip noting the time is recorded by the timekeeper and the elapsed hours are charged accordingly. Standard-hours credit is obtained from the finished inspection reports of quantities, multiplied by the group standard-time.

STANDARD TIME WAGE SYSTEM OF THE WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY

Standard names or occupations are selected for the various kinds of work. Five classes of work are established to cover all the work in the industry. A definite range of basic day rates is established for each class of work so that all employees rated in the same class are receiving practically the same rate. The range of basic day rates allowed for each class conforms very closely with the prevailing rates being paid for occupations placed in that particular class.

Following the standardization of occupations and basic day rates came job analysis and job specifications. In order to insure justice, a system of grading and rating employees was adopted. A service record card was designed which provides for periodical grading of employees based upon the qualities decided upon, and in line with the method of grading adopted.

The forms of wage-payment which had previously been used in different departments in the works were day-work, piece-work, premium and the Gantt Task and Bonus system. Just as it had been found advisable to standardize occupations, rates and methods of grading, it now seemed advisable to devise one incentive system of wage-payment. Careful consideration was given to the essentials of a satisfactory wage-payment plan, stress being placed upon such factors as standardization, fairness, flexibility, and simplicity. These factors, together with other desired factors, seemed to be most fully incorporated in the system adopted, known as the Standard Time system.

Standard time is the time required by an average operator, working under normal conditions, to perform a certain piece of work. The plan is applicable to individual or to group work, being most generally applied to small groups of about ten or less.

The fundamentals of the Standard Time system of Wage-Payment are:

(1) Correct time values representing the time in which work should be done by an average operator under average or normal conditions.
(2) A day rate which corresponds in value to the day work rate being paid for similar jobs in the same community.
(3) A standard time rate which exceeds the day rate by a definite percentage.

Under standard time the operator's earnings are calculated as follows: If the operator performs the work within the allowed time,

his earnings are equal to the product of the number of standard time hours made and his standard time rate. If the operator fails to meet the allowed time, his earnings are equal to the product of the actual time worked in hours and his day rate.

The most satisfactory methods for establishing standard time are by formulae and time study. From time study it was found that certain variations in manufacturing specifications were responsible for a change in the time necessary to perform the job. The rate man determines the relationship existing between these specifications and the time required to perform the work.

Two of the principal adjuncts of the standard time system are the "Fall Down" card and the performance chart. The "Fall Down" card is a card which is made out when the operator fails to meet the time allowed. The performance chart is a chart which shows graphically the efficiency of each operator as well as the entire department. The following information is shown on the performance chart:

Name of each employee, check number, date hired, time taken on each job, number of hours worked per day, time allowed for each job, number of standard time hours made per day, number of absentees either voluntary or forced, number of "Make Outs," number of "Fall Downs," reasons for "Fall Downs," number of hours worked on regular day work, number of hours worked on contract day work and the daily, monthly, individual, group and section efficiencies. The performance chart is kept up-to-date daily and in some departments operates on a regular schedule. At certain specified intervals the chart is taken to the foreman, rate foreman, general foreman, and superintendent for their perusal. Provision is made for their signatures, indicating that they have seen the chart.

The management early gained the confidence of the workers by adopting the policy that a standard time value, once set, could not be decreased unless some change in the method of manufacture was effected. This in itself has been an incentive for the operator to produce without fear of being penalized for his efforts.

The foregoing pages summarize incentive wage system practice from the beginnings of Taylor, Gaunt, Halsey, Emerson, Towne and other pioneers, to the more recent group methods—which are coming into general use excepting where an individual and his machine constitute an unrelated "we."

PART III

INCENTIVE SYSTEMS IN OPERATION

THE remainder of this volume is devoted to the presentation of actual cases.

The executive who is contemplating the installation of an incentive system will gain many valuable suggestions from a study of this case material.

He will learn why certain companies decided on the particular form of wage systems and incentive plans they are using, and how they tried to make ready for its installation. He will learn of numerous defects which had to be overcome and how this was done.

Finally, he will have valid testimony as to the probable result through the operation of the plans in various conditions.

III

A SURVEY OF WAGE-PAYMENT PRACTICE

A REPORT recently made by the Committee on Industrial Relations of the National Metal Trades Association gives a representative cross-section of wage-payment methods in the metal-working industry which will be of great interest to all employers making a study of incentive payment.

Of the 672 plants covered by the survey, 307 or 45.7 per cent paid employees on a straight-time basis. Some form of incentive plan was used by 365 plants, 54.3 per cent, while 49.3 per cent of the employees of these plants were paid on a time basis. Thus it will be seen that nearly three-fourths of the workers in the plants studied are paid on a time basis.

The incentive plans used in the 365 shops are predominantly of the simplest types, that is, piece-work and 50-50 premium. Two or more incentive plans were used in 88 shops, or about one-fourth of those in this group. A total of 489 incentive plans were used, distributed as follows:

247 or 50 per cent were piece-work plans;
104 or 21 per cent used a premium basis;
53 or 11 per cent were bonus plans;
33 or 7 per cent used group plans;
52 or 11 per cent of the plans were of miscellaneous type.

The report also sheds light on the history of payment plans in the various shops. Out of 245 shops reporting on this feature 70 per cent still use the incentive plan originally adopted. The original plan was abandoned for another incentive plan in 20 per cent of the plants, and for straight-time payment in 10 per cent.

Group incentive plans were used in 33 plants, being the only plan used by 4 of the companies. The other 29 use the group plan in combination with individual plans.

Supervisory incentive plans were used by 79 of the companies. They were distributed as follows:

24 or 34 per cent were based on some plan of profit sharing or Christmas bonus dependent on company earnings;

19 or 24 per cent were based on departmental plant production;

15 or 19 per cent were based on economies shown by the group;

14 or 17 per cent were paid on the basis of earnings of the supervisor's subordinates;

7 or 9 per cent of the plans were based on a combination of two or more factors.

The study also covered the methods used in establishing piece-rates. Of the 256 member plans reporting on this:

112 or 43 per cent set standards by time study exclusively;

79 or 31 per cent used time study in combination with other means;

43 or 17 per cent based rates on previous performance;

22 or 9 per cent established standards by estimating methods, ranging from careful tables of weight down to more or less scientific guesses.

In 75 per cent of the cases no one individual was empowered to establish the rate without a check by a separate staff department, foreman, or other authority.

40 PER CENT SAVING IN WORKER'S TIME THROUGH MOTION TIME ANALYSIS

By E. E. BRINKMAN
Industrial Engineer, Holeproof Hosiery Company

TO REDUCE the cost of manufacturing hosiery below the point reached by stop-watch time study, we recently introduced motion-time analysis. By totaling the time required for each fundamental motion in the cycle, a forecast was made as to the time which would be required for each operation if our layout were correctly made. These time formulae are very few in number and we believe, are common to all industrial operations. In this portion of the work we were assisted by our consulting engineer, Mr. A. B. Segur.

All of this preliminary work was done and the new method and time were known before any operator had been placed on the new job, or any trial of the proposed change had been made.

Operators were selected by test from the workers on the old method. These operators were given preliminary instructions on

the motions to be performed by them from the analysis sheet, so that the experimental fixtures could be tried out. This made possible the development and simplification of the fixtures and tools so that mechanical difficulties usually present in a new tool or machine, could be overcome.

When the job was ready for final standardization, the motion time analysis was revised on the basis of the final fixtures. Subsidiary operations were analyzed and times established to be included in the computation of the production task and piece-rate. (Figure 1.)

It is interesting to note that the difference between the saving shown to be possible on the final analysis of the new method and the savings shown possible on the first audit differed by only 3½ per cent.

The final test of any highly developed method of job-analysis or

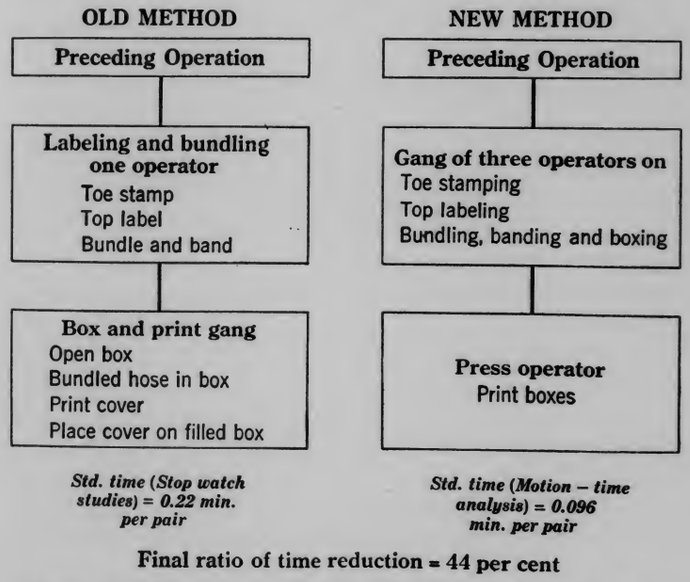


FIGURE 1. *By eliminating unnecessary motions the new method brought about a large saving in time*

improvement project through the process of research lies in its successful operation as an instrument of economy and enhanced quality. The adaptation of the user of such an instrument through training is necessarily a major part of its successful operation. This was found decidedly true of the introduction of this new method of labelling and bundling hosiery. The operators selected were taught the path of motions in the new job by the aid of charts such as is shown in Figure 2.

This chart is an effective descriptive summary of the details of the motion-time analysis sheets. The operator is aided thereby to visualize the job and the sequence and extent of the motions. It also shows at a glance the motions of each hand that should be performed at the same instant. This acts as an aid to the trainer in detecting irregularities of the motions performed by the operator under instruction.

When an operator goes through the motions prescribed on the analysis sheets it is obvious that the time taken for the job will also be determined in the analysis. Now the stop-watch is used to measure the overall time of the complete cycle. A comparison of the overall time with the standard time gives a quick measure of the degree of fidelity to the prescribed motion paths, exercised by the operator. For example, if the time on a cycle is 0.045 min. and the stop-watch readings on overall time is 0.06 min., it is evident that there are unauthorized motions being performed by the operator, the total time being 0.015 min. The trainer then proceeds to find these unauthorized motions in order that the operator's time can be brought down to standard. The training process has been divided into two stages:

1. The preliminary training of motion paths by the aid of motion-time charts and the analysis sheet job description.
2. The detection of unauthorized motions introduced by the operator under training. This stage obviously also covers the coaching of the operator in the motion paths with the elimination of these unauthorized motions.

Several weeks in training were required to bring the operators down to standard time on this first operation. Everyone, including operators, foremen, time-study engineering staff, who changed to motion-time analysts, and the management, had to be convinced that it could be done. This required time and extended the training period beyond what it has been on following jobs. When the training was complete, the minimum time for each individual operator was so close to the time that had been calculated months before, that it was impossible to read the difference on the stop-watch.

Our last job set up on the basis of motion-time analysis required 10 days of training to bring operators down to standard cycle time, which showed an improvement of 60 per cent over the former method of operation. As the proficiency of trainers improves, through accumulated experience, it is expected to have the training period become a matter of several hours on almost any job.

When the operators are hitting standard time quite regularly they are considered ready for piece-work operation. The standard production for a gang of three operators on this new job was 160 equivalent dozen per hr. Up to this time of writing, the production for an entire 8-hr. day has averaged 152 dozen per hr. While the difference is relatively small, this can and will still be eliminated by avoiding certain operating delays beyond the scope of the time and rest allowances provided in the system of motion-time analysis.

It has been a matter of great interest to see a number of operators on the same new job produce equivalent amounts with no more than 10 per cent variation per day in contrast to the former condition on the operation where the fastest operator produced 100 per cent more than the operator of lowest efficiency, although all were apparently following the instructions on the operation car as set by job-analysis and time-studies.

In accordance with generally accepted wage policies in existence today, operators under training were placed on a piece-rate incentive, specially prepared for the operator under training. This differential piece-rate varied from 50 per cent to 33 per cent above the final piece-rate.

This training rate is put into effect for a predetermined period sufficient to bring the operators down to standard time. The final piece-rate is then put into effect. This final rate is computed from a base-rate that allows the operator a share in the economy as his reward for performing the motions of an expert. The new base-rate of $0.51 per hr. compares favorably with the former rate of $0.40 per hr. This higher base-rate then also acts as an incentive for former operators on the old method to adapt themselves willingly to the new.

The results of operation to date on the job designed according to the principles of fundamental motion-time analysis are as follows:

Standard earnings of operators.....$0.51 per hr. (formerly $0.40)
Savings per year.....$4,500 (40 per cent)
Cost of analysis work development and training.....$2,200

The savings pay for themselves in six months' time. This should be our maximum time for paying the cost of developing a job.

In addition to the above results, certain benefits evidence themselves which are vital but not readily measured by the dollar.

1. Processing time of a batch of hosiery is decreased by the increased speed of completion of the work on the batch.

2. Quality control of the product and workmanship is more definitely established because quality has become a problem of motions. In our development work the quality factor in the job was kept constantly in mind and many cases exist where definite motions were prescribed to give quality that would more than meet the standards set by the company management.

3. The training period for new operators is radically reduced by knowing what must be taught, thus making possible a more positive program of teaching by means of written description, charts of motion paths and demonstration.

The experience of the writer in the technique and procedure of motion-time analysis, covering a number of operations, as described in the preceding pages, has made possible first-hand observations and comparisons with the principles underlying our former methods of job-analysis. The science of management, with its most effective tools, job-analysis, motion-study, micro-motion study or motion-time analysis, has for many years been to me an object of much interest and study. Conclusions formulated from experience with this most recent development are set forth below:

1. (a) The worker supplies the knowledge of what he does.
   (b) The analyst or engineer supplies the mechanism for recording the method in terms of fundamental motions.
   (c) The management, through its functional agents, supplies the standard of quality.

From these primary sources the motions of the job are determined and the necessary equipment, in the form of tools, fixtures, and machines, is ascertained.

2. A job improvement program on a systematic and orderly procedure is made possible. One improvement is coordinated with other existing and future improvements on other operations preceding or following. This is in contrast to the frequent condition of one chance improvement having unquestioned merits conflicting with requirements of some preceding chance improvement.

Intelligent cooperation is possible on the basis of definite standards of time, motion and job-analysis and principles of evaluation of method instead of coincidence of opinions, friendship, and politics.

3. Fewer successive stages of job improvement are required because the job is all improved at once. The work takes longer but is worth the additional effort. Multiplication of rates of pay per piece is eliminated. This is exemplified by three rates in our plant replacing sixteen former rates, all of which were in effect at one time.

4. The question of responsibility for making the task production and the scheduled earnings is no longer with the operator but is definitely in the hands of the trainer, the foreman, and the engineer. It is the responsibility of these functionaries to put into use the proper and prescribed motions, and to keep the working conditions, tools, equipment and material up to the prescribed standard so that the proper motions can be performed.

5. Question of authority is non-existent. In motion-time analysis there is no place for the exercise of arbitrary authority on the part of anyone. For example:

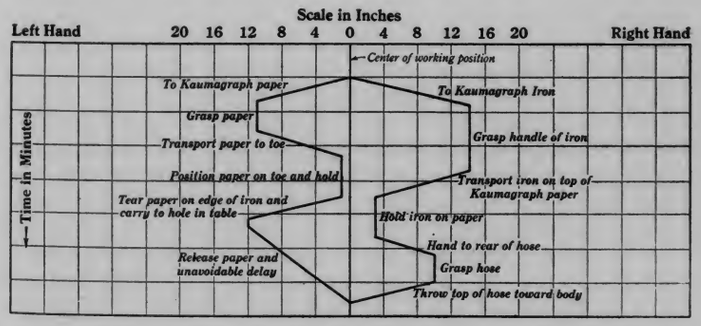


FIGURE 2. *Operations were graphed to show time consumed and distances covered during fundamental motions*

Formerly, the question of whether an operation should be worked on a group or individual basis was primarily a question of the policy of wage-payment in effect. Now it is a matter of the ease of operation and the elimination of motions that supplies the answer.

Thus: Under our former practice of job analysis, two operations consisting of hem-folding and of hemming the fold were separate as a matter of custom. They were later combined into one operation performed by an individual operator, paid on an individual wage-payment plan. When this operation was subjected to a motion-time analysis, the audit showed that two operators working in a team could perform the job and still have a third operation made a part of the work of the two operators. This team arrangement was adopted in the face of former practice in an opposite tendency because the analysis showed the possibility of eliminating the entire time of a third worker.

6. Because motion-time analysis gives a definite set of motions to be performed, the employment of a worker for the job by tests becomes merely the determination of the physical and mental ability of the prospective employee to perform this set of motions. Employment by tests becomes systematic without extra frills in the employment department.

7. There is no conflict with past and present stop-watch work. While the motion-time analysis work proceeds, the stop-watch work continues as much as is necessary in other departments without conflict in principles or policy.

8. A time-study sheet is primarily devoted to the showing of time for elemental operations adopted in the job-analysis. An analysis sheet is devoted primarily to showing the detailed method in terms of therbligs. The time shown on the sheet is secondary.

The time selected from the time-study sheet by one of a number of methods quite generally known is the result of a number of different observed times. In motion-time analysis, this variability of judgment and method of selecting the standard time does not exist because only one time is selected, namely, the correct time for a fundamental motion.

9. No rates of piece-work pay are reduced. With a definite control of all motions, most of the work is done under one rate without the possibility of a change in the method of work soon bringing in a justified lower rate. Even though lower rates for improved operations of methods determined from time-study are justified, employees still think it is a "cut" in the rate. "Convinced against their will, they are of the same opinion still," is particularly true in this instance.

10. Meetings with the foremen train these men in motion-time analysis work long before the actual work can be started. By virtue of their training, they are formulating improvements in advance. This is an aid to scientific job improvement because many of the problems are solved before the real analysis is made.

11. Principles of motions and equipment formulated in one department can be adopted in other departments. Analysis for groups of motions can be used in any department where they apply with definite assurance that the time obtained in one place will work elsewhere, because the detailed method description gives control of the fundamental motions, which will otherwise always be at least slightly different in proportion to the difference in methods and opinions of the individuals and foremen.

12. In motion-time analysis lies the possibility of different companies using fundamental time data on sets and groups of fundamental motions ordinarily termed in time-study practice as elemental times. The fulfilment of Frederick W. Taylor's hope of a handbook of standard times now seems possible, because the motions underlying the "elemental time" are recorded and under control.

The adoption of motion time analysis as a system of analyzing motions of our factory operations has not acted as a panacea for all ills and problems. It has, however, been proven that it is a constructive means of definitely controlling most of the direct labor in our manufacturing operations. This is extremely vital to us, because direct labor of a high skilled grade represents a comparatively large portion of our manufacturing cost.

The seemingly spectacular results obtained from the use of motion-time analysis has not been achieved by the exercise of mystic powers but have come from hard work in analysis, development and training on the part of all that were identified with the work. We shall continue to observe the rule that:

(1) Careful analysis of motions and time; (2) accurate selection of adaptable workers, and (3) systematic training in motions represent the essentials which with organized cooperation, will make possible better quality, lower costs and higher wages.

COST CUTTING THROUGH TIME STUDY

By WALTER C. HASSELHORN
Supervising Engineer, Stevenson, Harrison and Jordan, Chicago

TIME study is now recognized as an effective means of measuring employees' efforts, determining machine output, standardizing methods, stabilizing labor, controlling costs and increasing production or—to sum up in a single phrase—securing manufacturing betterment. This process of securing manufacturing betterment may be considered in three phases—investigational, analytical, and functional—all important, interrelated, and effective.

Time study should at no time be regarded as an incidental clerical function of minor importance, but rather as an engineering practice whose application to management betterment procedure is to be supplemented by the investigational and analytical phases if full benefits are to result. Because the accuracy of the time standard is vital to usefulness, time study should always be conducted by qualified observers who will work only on an accurate and scientific basis.

The engineer employed as a time study observer must possess certain qualifications and must bring to his practice a balance between correct understanding of fundamentals and theory and a practical application of the same to the problem. Too much theory, coupled with an insufficient practical knowledge, is a poor basis for the work; while on the other hand, practical knowledge without sufficient education or training as regards fundamentals does not give proper equipment to the observer for interpreting the various time study and production details.

Managers, therefore, should give this department of their business careful consideration, for by it the standards of effort measurement are determined and the bases established for compensating employees for time-saving, proficiency, and effort. These standards are comparable to the values which determine material purchase, and with the present regard for healthy industrial relations, the importance of their accuracy cannot be over-emphasized. Haphazard rate-setting by means of estimates, past performance, records, tests based on overall times, opinions, and faulty time-study practice is a dangerous procedure, and certain to yield a figure which only approximately determines an index of efficiency. If such a value, when used as a wage-incentive standard, is inequitable

and in excess of a fair normal output, it encourages haste and therefore waste, or discourages any attempt at efficient performance; and if below normal, either the earnings are excessive, or production, for fear of rate readjustment, is restricted.

The assurance of increased earnings for employees coupled with increased production, a saving of time, and a reduction of manufacturing costs, calls for a practice founded on correct basic principles. A method which has proven satisfactory and answers the above requirements is described herein.

Just as the technical engineer investigates the factors that will affect the building of a structure or the manufacture of devices, in order to insure a satisfactory and permanent result, so the investigation of production factors affecting an operation is important when standardizing and evaluating an operation or task.

The investigation is essential not only because a definite correlation of production factors to time standard in terms of definite characteristic must be established, but also because the examination of conditions, methods, mechanics, performance, and similar factors presents a direct means of improvement.

Briefly, the investigational phase includes a preliminary survey of all facts pertaining to the operation to be studied. It involves the correction of faulty motions, recommendations concerning improved tools and devices, elimination of unnecessary fatigue-producing elements, and the determining of correct methods, as well as the recording or consideration of facts pertaining to the operation which are related to the product and its materials. This section of the work is important and contributes much to the improvement of methods and performance, the correction of inconsistencies, and the elimination of all unnecessary elements.

The amount of investigational work necessary is governed by the degree in which methods and equipment, material and products, quality and inspection factors, personnel and occupations have already been standardized, simplified, or controlled. As standardization progresses, the facts pertaining to the conditions become known and definite records of their elements are available.

Information pertaining to feeds and speeds for various machines and tools and related to the materials, craft classification and occupational rating, tolerances, material specifications, and tools or equipment, are the usual production elements that can be rated or classified as standard factors.

Where the shop is operated on a day-work basis and without regard to scientific management principles, a general shop clean-up and improvement of working conditions is recommended before any time study work is attempted. This clean-up may be classed as a part of the preliminary survey, for it is important that all variables caused by neglected or poor working conditions be eliminated. It is obvious that men will work more efficiently in a shop where orderliness and cleanliness are in evidence.

Fatigue-producing elements are at least 14 in number and consist of:

1. Excessive muscular exertion
2. Haste—speeding up
3. Incorrect posture
4. Long work periods
5. Improper illumination
6. Temperature extremes
7. Poor ventilation
8. Monotony
9. Irregular performance
10. Irregular personal habits
11. Negative mental state
12. Noise (din)
13. Mechanical inconsistencies
14. Hazards

The means by which they can be eliminated or corrected are:

1. Mechanization of manually performed tasks
2. Correct incentives and regulated production
3. Motion study, proper seating, benches, etc.
4. Consistent work periods
5. Adequate illumination
6. Temperature control
7. Correct air conditioning and ventilation
8. Variety, rhythm-relation and authorized rest periods
9. Planning, scheduling, dispatching, specialization
10. Proper hygiene and physiological care
11. Healthy industrial relations—Interest
12. Correct machine design and proper maintenance
13. Safety engineering

Such detailed investigation of manufacturing operations as is suggested in the foregoing obviously provided a direct and immediate means of waste elimination by improvement and standardization of operations; hence the investigational phase of time study is in itself an effective means of manufacturing betterment.

The analytical phase may be defined as the technique of operation study and evaluation. Correct practice based on certain fundamental principles and consisting of definite operations is here essential. The following are the detailed steps:

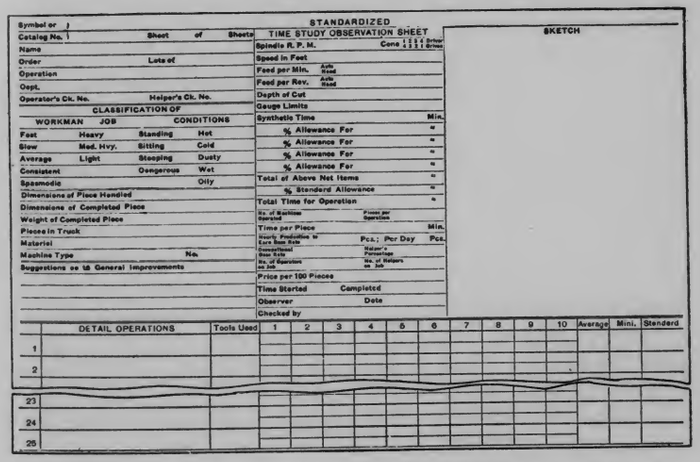
Operation analysis
Recording the operation elemental times
Time analysis

Synthesis
Determining and adding allowances
Conversion

Operation analysis consists mainly of breaking down each operation into its recurring elements, that is, the motions or groups of motions of short duration which can be accurately recorded as stop-watch readings. The termination of these elements is announced by the jar or oscillation of machinery, the movement of parts or operator, and certain noises of machinery or tools.

The arrangement of these operation elements is of primary importance and a properly designed observation sheet such as shown in illustration, aids considerably toward the correct analysis of the operation. "The greater the number of elements the operation is divided into, the more accurate the time study will become" is a rule which should be strictly adhered to.

The reading of the watch or the recording of the elemental times of the operation follows and by this means the operator's performance is related to the operation elements in terms of decimal time values ranging from 0.02 min. up. Accuracy of watch reading is


STANDARDIZED
TIME STUDY OBSERVATION SHEET

Symbol or Catalog No. | Sheet of Sheets
Name
Order | Lots of
Operation
Dept.
Operator's Ck. No. | Helper's Ck. No.

CLASSIFICATION OF

WORKMAN		JOB	CONDITIONS
Fast	Heavy	Standing	Hot
Slow	Med. Hvy.	Sitting	Cold
Average	Light	Stooping	Dusty
Consistent		Dangerous	Wet
Spasmodic			Oily

Dimensions of Piece Handled
Dimensions of Completed Piece
Weight of Completed Piece
Pieces in Truck
Material
Machine Type | No.
Suggestions as to General Improvements

Spindle R. P. M. | Cone 1 2 3 4 Drive / 1 2 3 4 Driven
Speed in Feet
Feed per Min. | Adv. Used
Feed per Rev. | Adv. Used
Depth of Cut
Gauge Limits
Synthetic Time | Min.
% Allowance For | "
% Allowance For | "
% Allowance For | "
% Allowance For | "
Total of Above Net Items | "
% Standard Allowance | "
Total Time for Operation | "
No. of Stations Operated | Fixed per Operation
Time per Piece | Min.
Hourly Production to Earn Base Rate | Pcs.; Per Day | Pcs.
Conventional Rate of Pay | Helper's Rate
No. of Operators on Job | No. of Helpers on Job
Price per 100 Pieces
Time Started | Completed
Observer | Date
Checked by

SKETCH

	DETAIL OPERATIONS	Tools Used	1	2	3	4	5	6	7	8	9	10	Average	Mini.	Standard
1															
2															
23															
24															
25															

A standard form of time study observation sheet is used for recording operation data, time readings, and computing the task standard

all important and reading the watch at the exact instant of the cut-off point of the operation element is essential. Practice is required before short cycle readings recurring frequently can be accurately recorded.

Numerous methods are used in analyzing the elemental time values of the operation, and various formulas, rules, deviation ratios, etc., are brought into play.

By retaining only those readings which are less than the average time and greater than the accepted minimum time for completing the operation, can a satisfactory leveling off or method of cut-outs be had. Readings not in this class should be stricken out and those containing time required to perform an incidental operation should be properly symbolized and later considered in the determining of the incidental allowance factors.

Following the time analysis in the scientific determination of task standards, comes the synthesis or the assigning of standard time values to each operation element, the total to represent the best or 100 per cent time in which an operator of average experience and proficiency can satisfactorily complete the task under consideration. Diverse practices are being employed for this—formulas, average of averages, the average of the averages and minimum, and selection of the consistent performance standard times, etc., being some of the common types employed. This evaluating of the operation elements must be done with care, and this base time may be likened to the sum of the fundamental therblig values resulting from the micromotion method of operation study and task evaluation.

In order to make this theoretical or 100 per cent base time a practical figure, it is necessary to add certain allowances, both incidental and standard.

The incidental allowances can be defined as time allowances which provide for intermittent or incidental operation elements whose motions differ from those prescribed in the regular operation detail. Standard allowances cover specific determinable delays.

In order to permit the operator the necessary time for personal care, a time allowance for morning and afternoon recess and for each sex should be added to the base time, using a percentage figure determined by the relation of recess time to the length of the work day.

A profit factor should be included when the standard is to be used as a means of effort measurement in determining wage in-

centives, especially when the regular hourly base rate is used as a basis for calculating the premium earnings. This allowance provides the incentive for the workman consistently to maintain the base time determined and to utilize the prescribed allowances as intended.

An allowance to compensate for minor or unavoidable delays should also be considered, and related to the conditions affecting the operation and product and the natural variance of the operator's performance.

When the operation is of such a nature that the operator's performance is affected by the cumulative fatigue factor, which is not offset by the recess period allotted in the personal care factor, a recuperation allowance is required. By classifying the task as normal, medium heavy, heavy or extra heavy, and assigning to each of these a definite and carefully determined rest period time value, a method of providing for sufficient recuperation is obtained.

The base time when affected by the foregoing allowance factors becomes a standard time, which when converted to a convenient or suitable expression is applicable as a means of effort measurement.

The formula for this conversion reads:

$$\frac{60 \text{ min.}}{\dfrac{\text{Standard time}}{\text{No. units produced} \times \text{No. of producers}}} = \text{Standard production per operator hr.}$$

$$\frac{\text{Hourly basic rate}}{\text{Standard production per operator hr.}} = \text{Piece-work price}$$

The determination of the task standard expressed as a definite value in terms of a determined unit of measure completes the analytical phase of the time study, and there remains only the application of the time standard and time study practice to shop management.

The advantages accruing from such a detailed and analytical study are many, and are especially evidenced when the time study practice is applied to various production functions.

The developing of operation elemental time standards for use in connection with the developing of synthetic rates and formulas is an important phase of this work, and the availability of such basic values is a considerable advantage, especially when the study applies to jobbing, maintenance, repairs and similar irregular operations.

The developing of formulas to be used in connection with rating

machinery, such as stickers, planers, automatic saws, screw machines, etc., makes possible the determination of accurate and comparable time standards, and requires only a minimum observation after the production factors affecting the job have been standardized.

By the study of operations the workmen performing them come under close scrutiny and when the values are applied to comparable operation elements performed by several operators, each having been individually studied, improved performances result.

Analysis of the study often discloses poor practice not discernible by casual observation. Such details as using bolts of an excessive length, faulty jigging devices, or improper arrangement of tools and parts are disclosed when the observer makes his operation analysis, time observation or time analysis. These details are often overlooked when making the preliminary survey.

HOW 1,000 STANDARD TIME RATES WERE SET ON THE BASIS OF 100 TIME STUDIES

By SAMUEL A. PECK
Time Study Engineer, Van Dorn Iron Works

IN DETERMINING, installing and maintaining rates for piece work or premium methods of payment in any shop manufacturing a variety of articles having a progression of sizes, the first difficulty encountered is the immense number of individual time studies and rate sheets required to cover the range of the product sizes, particularly if there is no organized groundwork of time study data to start with.

In order to eliminate this detail and release the time study observers for more important work, the writer developed a method of data analysis and synthesis that enabled the time study department of the Van Dorn Iron Works plant in Cleveland to set rates for over a thousand weights and sizes in various departments, on the basis of fewer than a hundred time studies in each department.

This method of analysis consists of six phases:

1. Breaking down operations into convenient, practical, elementary cycles of time, or units of work;
2. Classifying these units, or "elements" as they were called, into similar sized groups;

TABLE 1. STANDARD LIFTS AND LOADS
(2-man crew)

Gages	Width (Ins.)	Length (Inches) 60		72		84		96		108		120	
		A	B	A	B	A	B	A	B	A	B	A	B
10, 11	24	1	60	1	50	1	50	1	40	1	30	1	30
	30	1	50	1	40	1	40	1	30	1	30	1	30
	36	1	40	1	40	1	30	1	30	1	20	1	20
	44	1	30	1	30	1	30	1	20	1	20	1	20
12, 13	24	2	80	2	60	2	60	1	50	1	40	1	40
	30	2	60	2	50	1	40	1	40	1	40	1	30
	36	2	50	1	40	1	40	1	30	1	30	1	30
	44	1	40	1	40	1	30	1	30	1	30	1	30
14, 15	24	3	100	3	90	2	80	2	70	2	60	2	60
	30	2	100	2	70	2	60	2	60	1	50	1	50
	36	2	80	2	60	1	50	1	50	1	40	1	40
	44	2	60	1	50	1	40	1	40	1	40	1	30
16, 17	24	4	150	3	150	2	100	2	90	2	80	2	70
	30	3	100	3	100	2	80	2	80	2	60	2	60
	36	3	100	2	80	2	70	2	60	1	50	1	50
	44	2	80	2	60	1	60	1	50	1	40	1	40
18, 19, 20	24	4	200	4	150	3	150	3	150	2	100	2	90
	30	4	150	3	100	3	100	3	90	2	80	2	70
	36	3	150	3	100	2	80	2	70	2	70	2	60
	44	3	100	2	80	2	70	2	60	2	60	1	50
21, 22, 23, 24	24	5	300	5	250	4	200	4	150	4	150	3	150
	30	5	250	4	200	3	150	3	150	3	150	2	100
	36	4	200	3	150	3	150	3	150	2	100	2	100
	44	4	150	3	150	3	100	2	100	2	100	2	100

STANDARD LOAD=3600 LBS. A=Sheets per lift. B=Sheets per load.

3. Determining the relation of these elements to the progression in size and weight of the product;
4. Charting these elements graphically in the same relations to each other that the sizes and weights of the product bore to each other;
5. Synthetically (or comparatively) extending these known points to cover the complete range needed; and
6. Organizing the charts and routine required to set the rates as needed.

The first department in the plant selected for equipment with these rates was the sheet steel stock room, rates being required for the operation of unloading and storing in piles the various sizes and gages of sheets used in the product.

Several preliminary studies convinced the writer that detail elements were impractical, as we were dealing with rate-setting primarily, and not with a study of material handling, which had necessarily preceded the rate-setting studies. The object of the rate setting investigation would hence be fully accomplished by combining the individual motions performed on the job in operation groups. It was therefore decided that the basis upon which we would make our data studies would be as follows:

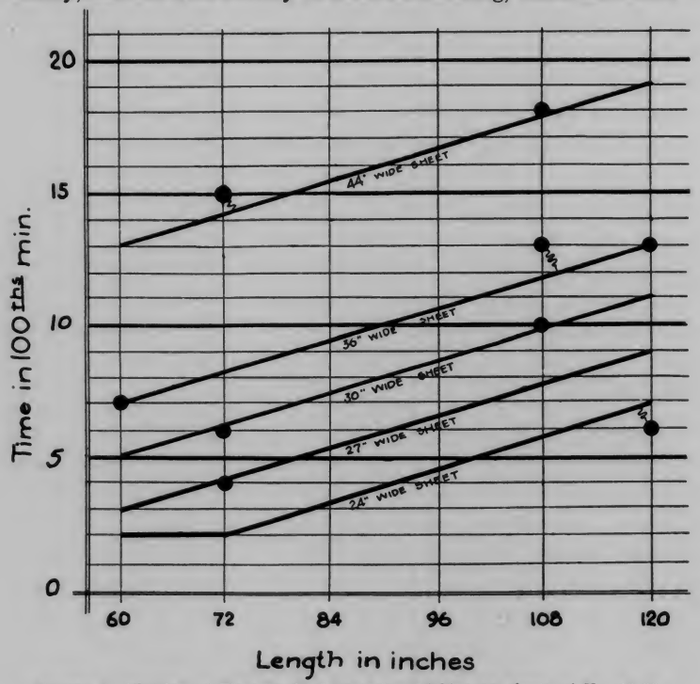


FIGURE 1. *Plotting of Element A of operation, picking up sheets of No. 18-20 gage steel and placing them on trucks. The time given is for one sheet*

ELEMENT	OPERATION	REMARKS
A	Pick up sheet(s) and place on hand truck	Variable
B	Truck to stockroom pile	Constant
C	Unload sheet(s) and pile carefully	Variable
D	Return empty truck to car	Constant
E	Position truck in car	Constant

During the course of these time studies, careful observation was made of weights handled and moved, sizes, methods, operators, etc. From these time studies, when carefully analyzed for sizes and number of pieces handled, the manner of handling, and working effort involved, with delay and fatigue allowances, we derived auxiliary tables of data that gave us standardized lifts, weights, crews, etc.

Table 1 is an example of some of this derived data.

After determining standard lifts, loads, and operators from the customary procedure in time study analysis, the next problem was to determine all the element times needed from the ones actually observed and recorded.

It was found that B, D, and E were constant-time elements and therefore did not require charting or indexing. They vary, of course, with the local conditions in any plant.

The first step, then, was to plot on a standard graph paper, using "time-size" axes, the actual element times recorded, in order to find the characteristic curve. It was found that within the size ranges used in this plant, a straight line passed through practically all points, as shown in Figure 1, a factor that simplified materially the determination of unknown element times.

As a matter of fact a complete curve covering an entire range of sizes was found to be of the usual parabolic form.

The next step was to plot once more, on transparent chart paper, the points for the element times for the gage having the most actual observations—one chart for each variable element—and to draw

heavy parallel straight lines through the points for each size of sheet steel.

Using the same scales on another sheet, the next heavier or lighter gage was plotted. This sheet was then superimposed on the first sheet and straight lines were drawn parallel to the lines on the first sheet, but intersecting the points on the second sheet. (See Figure 2.)

This was continued until all elements on all gages had been charted. It was found that on end gages or sizes the lines were frequently drawn "in the air," but the data secured therefrom was just as accurate as the empirical determinations.

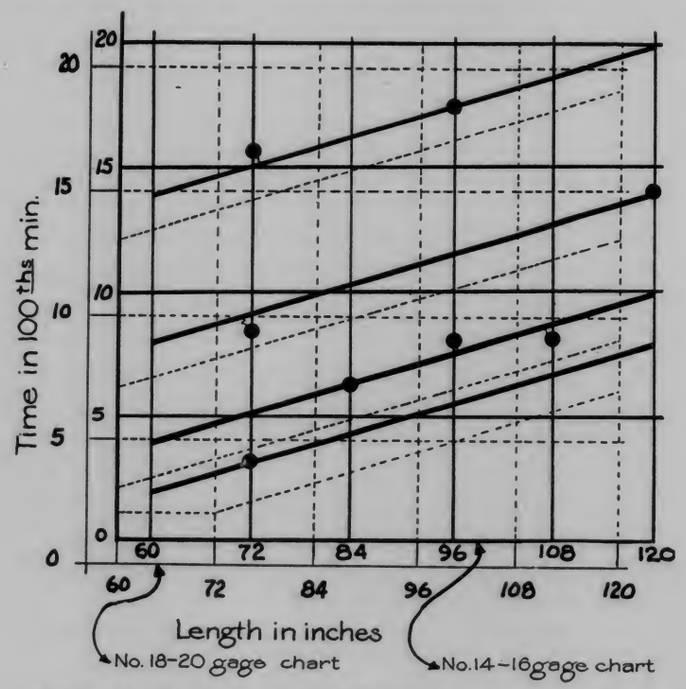


FIGURE 2. *Method of developing the time curves for No. 14-16 gage sheets from No. 18-20 gage sheets to establish approximately uniform gradations for the different weights and widths of sheets*

TABLE 2. ELEMENTS A AND C: STANDARD TIMES PER SHEET IN HUNDREDTHS OF ONE MINUTE

Gage	Width (Inches)	Length (Inches) 60	72	84	96	108	120
10	24	7	8	9	10½	11½	13
11	30	11	12	13½	14½	16	17
12	36	13	14	15½	16½	18	19
13	44	19	20	21½	22½	24	25
14	24	4	5	6½	8	9	10
15	30	8	9	10	11½	13	14
16	36	10	11	12½	13½	15	16
17	44	16	17	18½	19½	21	22
18	24	2	2	3½	4	5½	7
19	30	5	6	7	8½	10	11
20	36	7	8	9½	10½	12	13
	44	13	14½	15½	17	18	19
21	24	2	2	2	2	3	4
22	30	2	3	4½	5½	7	8
23	36	4	5	6½	7½	9	10
24	44	10	11	12½	13½	15	16

If the data taken has been correctly plotted, the increments (vertical distances) between sizes on one graph sheet, and between gages on different graph sheets, should be uniformly progressive.

After all the graphs had been drawn, compared, and checked, the rate-setting chart was made up. This was merely a tabulated summary of the graph readings for the various sizes and gages. Table 2 gives the actual results found by the writer. In this case there was found to be so little difference between elements A and C that for practical purposes they were combined.

These element times are of course net, normal times, and should

have added to them the necessary standard delay and fatigue allowances, depending on the local conditions in each plant.

In order to index properly and locate easily the various rates set, the writer devised a 4-digit operation code number that is self-keyed and is used as a suffix in connection with the general code operation number for unloading sheets, which, for example, can be called "Operation 85."

This 4-digit system is shown in Figure 3, in which the digits used are indicated by the heavy type:

Examples of the use of the code may help to clarify its use:

Decode: Operation 85-2518
Answer: Unload and pile in Section 2, No. 16 gage sheets 30x96 in.
Code: Operation of unloading and piling in Section 3, No. 24 gage sheets 36x108 in.
Answer: To unload and pile is 85
Location Section 3.....3000
Gage No. 24..... 900
Size 36x108 in..... 32
Operation number is 85-3932

It must be remembered that rates determined in this manner require a spirit of "give and take" on the part of both employee and

FIG. 3—KEY TO THE 4-DIGIT CODE

Location	1st Dig.	Weight Groups (Gages)	2nd Dig.	Sheet Sizes: Length in Inches	Width in Ins. 24	30	36	44	
Section 1	**1000**	Gage 10	**100**	60	**00**	**12**	**24**	**36**	3rd and 4th Digits
Section 2	**2000**	Gage 11	**200**	72	**02**	**14**	**26**	**38**	
Section 3	**3000**	Gage 12–13	**300**	84	**04**	**16**	**28**	**40**	
Section 4	**4000**	Gage 14–15	**400**	96	**06**	**18**	**30**	**42**	
		Gage 16–17	**500**	108	**08**	**20**	**32**	**44**	
		Gage 18–19	**600**	120	**10**	**22**	**34**	**46**	
		Gage 20–21	**700**						
		Gage 22–23	**800**						
		Gage 24–25	**900**						

company. As a rule the rates so set will give the employee plenty of "edge" in the job, but certain end rates may not. In any case the end rates should be so set that with normal effort the operator makes at least his day-work rate.

As to the actual saving resulting from the use of this method, the following facts are a matter of record in the Van Dorn plant: An average labor saving of approximately 15 per cent has resulted from the use of these charts, due to the fact that the personal equation has been eliminated from rate-setting, since both the time study observer and the operator are timed. No deception by the operator can be practiced, as the rate is set by impersonal averages, from the office. Variations in judgment by the observer are eliminated in the same manner.

Indirect gains are: A better morale in operators after they once understand the system, and the reduction in staff effort due to the fact that a needed rate can be set in the office in about five minutes, instead of requiring an observer's time for an hour.

CONTROLLING THE OUTPUT OF SHOP LABOR

By W. R. WILLIAMSON
Vice-President and General Manager, W. F. Williamson Advertising Service

UNDER ordinary methods of management found in the majority of manufacturing plants, workmen are paid for their attendance as shown by time records predicated upon the use of the "in and out" clock sytsem, whereby the employee rings in in the morning and out at night. While such a system provides an accurate record of time elapsed between the punchings, it does not give any assurance whatsoever that the employee was actually engaged during such time on useful work. In fact, through connivance with fellow employees, it is possible for a dishonest workman to collect pay for time during which he was absent from the plant altogether.

Under the methods employed in connection with the Taylor system of scientific management, which we follow, the workman is paid for the actual time worked on assigned jobs, as shown by his job cards, plus a bonus if he has earned one.

Under this system an individual job card is issued for each job or operation upon which the operative is to work. Here is how it works out: The job cards for the first jobs of the day are placed in a rack the night before. When the rack is opened in the morning

			RETURNED ISSUE	CHARGE TO						
OPERATIVE'S NAME					NO.					
WORKPLACE		LOCATION		DRAWING NO.	IF NOT FINISHED SCRATCH	F				
					IF FINISHED SCRATCH	NF				
OPER. NO.	PIECE SYMBOL	LOT NO.		KIND OF OPERATION						
ORIGINAL NO. OF P'CS IN LOT										
NO. OF P'CS TO DO ON THIS CARD										
NO. OF P'CS FINISHED THIS CARD										
NO. OF P'CS STILL TO DO		WORKPLACE					OPERATIVE			
		TIME	REL. COST NO.		REL. COST		TIME	RATE	EARNINGS	
SCHEDULE	ROUTE SHEET	PROGRESS SHEET	PAYROLL	WORKPLACE RECORD	COST		DAY WORK JOB CARD			

Day work tickets are the job cards

each employee takes his own card fro mit and proceeds to his work.

These tickets which are taken prior to, or at, standard starting time are rubber stamped with this regular morning starting time. At starting time the rack is, in effect, closed and locked. This is accomplished by revolving the rack so that it opens into the office instead of into the space available to the workmen. The rack can be turned this way because it is pivoted in the wall separating the office from the other area.

The man who arrives late becomes an "exception" who must report at the window and sign a "late-arriving ticket," in order to obtain his job card. Job cards issued to late arrivals are rubber

stamped "Not on time," and the exact hour is clock-stamped at the time issued. This entire procedure is what is sometimes called the "exception" method of timekeeping. In order further to discourage tardiness, the late arrival may be required to wait 15 minutes or so before his card is issued to him.

If the first card assigned is completed before closing time of the day issued, the workman places the ticket or job card in the pocket marked "Time Cards" on the revolving wicket, and revolves the wicket 180 deg., which delivers the job card into the planning department, and automatically rings a bell to attract the attention of the dispatcher. Under this method the change to the next job is made in a small fraction of the time taken where jobs are "handed out" by the shop foreman.

The dispatch clerk time-stamps the job card with the time returned to the planning department, checks the completed operation on the route sheet, removes from the dispatch board the job card for the man's next job ahead, stamps the time issued, hands it to the man, who goes to his next job.

At the close of the day, all job cards are turned in to the planning

The workman gets a card each morning

At starting time the time card rack is revolved to face the production control desk

department, time-stamped with closing time, and sorted as to whether finished or not finished. New cards are written for all operations not finished and are placed in the rack to be removed by the workmen the next morning, as previously described. Job cards for finished operations are checked to the route sheets.

The job cards are then sorted by workmen's numbers, elapsed times computed, rates applied and amount of pay extended. These details are then entered on the workman's daily statement of time and earnings, which are in turn posted to the shop pay roll.

After the job cards are posted to the workman's daily statement, they are sorted by operation symbols and filed in the cost file behind cost-collecting cards for the operation. At the end of each pay period, or on completion of the operation, if before the close of the pay period, these cards are summarized and the details entered upon the cost collecting card from which costs are posted to the final cost sheets.

Behind this smooth-running and apparently simple routine lies an orderly system of classification and standardization throughout the entire plant. Upon this system rests the ability to route the work efficiently, insuring the steady flow of materials as needed, the proper balance of work ahead of each machine and operator, and an up-to-the-minute record of progress on every job.

All of the information essential to the production of a manufacturing order is assembled by the route clerk, placed in a route file, and turned over to the order-of-work clerk. Of first importance in

the route file is the route sheet. One of these is prepared for each component part of the product and for each sub and major assembly, showing each operation to be performed, together with the machine or work place to which the operation is to be assigned. For each of these operations job cards, move tickets and other routing papers are prepared and placed in a pocket in the envelope sheet facing the route sheet in the route file.

At the time indicated by the production schedule for the starting of a manufacturing order, the job cards are removed from the route file and "posted" to the "order of work" board. Each position on this board, consisting of a clip and two pockets with machine symbol check hook, represents a machine or work place in the shop.

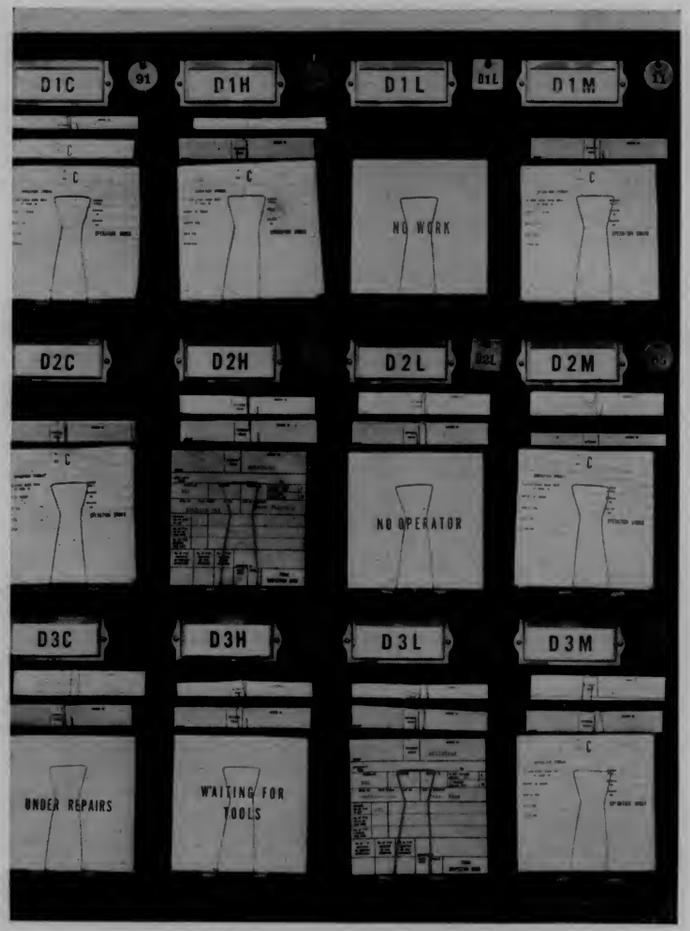
OPERATIVE'S NAME _____ NO. _____

WORKPLACE	DAILY STATEMENT YOUR TIME AND EARNINGS WERE AS FOLLOWS ON	MON.	DAY	PAY PERIOD ENDING MON.	DAY	YEAR

	TIME IN HOURS AND 10THS	TIME ACTUALLY WORKED		PREM. TIME EARNED		PREMIUM EARNINGS	
PREMIUM WORK	JOB BEGUN THIS DAY BUT NOT FINISHED, OR CARRIED OVER THIS DAY BUT NOT FINISHED						
	JOBS BEGUN AND FINISHED THIS DAY						
	JOB CARRIED OVER AND FINISHED THIS DAY						
	TOTAL TIME WORKED AND DAY WAGES ADVANCED	A					
	TOTAL EARNING ON PREMIUM WORK					G	
	TIME WORKED ON DAY WORK AND DAY WORK WAGES	B				H	
	TIME ALLOWED FOR OVERTIME AND AMOUNT OF RETAINER					J	
	TOTAL TIME WORKED AND TOTAL EARNINGS A+B=	C		G+H+J=		K	

PAYROLL	OPERATIVE'S RECORD	REPORT PROMPTLY IF THIS STATEMENT DOES NOT AGREE WITH YOUR OWN ACCOUNT _____ SIGNED _____		

Daily statements show each man's earnings



The status of each machine is kept posted

The cards are placed upon the board with reference to the sequence in which they are to be started. Cards placed under the

The board at the left shows the jobs and machines assigned to the various workmen

clip, or first position, show the jobs which are being worked on. The pocket immediately behind the clip contains cards for jobs for which material is at the machine and ready to be worked on; cards in the back pocket represent the jobs ahead of the machine, but for which materials have not yet been prepared and issued.

For each machine or work place a set of square brass checks, bearing the symbol of the machine, is provided. The number of the checks provided for each machine corresponds to the number of men required to operate the machine. As the job cards are issued to the operatives, the machine checks are placed on the assignment board, opposite the names and numbers of the workmen assigned to the machine. This cross-indexing makes it possible for one to determine at a glance where all the operatives are working and which operatives are assigned to the various machines and work places in the shop.

Another function of this order-of-work board is the ready indication of production conditions in the shop. This indication is possible because colored cards bearing such designations as "No Operator," "No Work," "Under Repairs," and so on, are employed.

In addition to the manufacturing order cards, the order-of-work board also carries information pertaining to maintenance work and

miscellaneous work orders, in fact all work that is being done in or is scheduled for the shops. By means of this mechanism and the route sheets, filed in the rack under the board, it is possible for the manager to keep in close touch with every operation without going into the shops at all.

Those familiar with the Taylor system of scientific management will recognize in the above description a very close following of the general scheme of organization and operation devised by Taylor and his associates. We have adhered closely to these methods because they accomplish the definite purposes for which they were designed better than any other plan we could adopt. As has been outlined, the procedure followed gives accurate time-keeping, exact records, maximum output, close control over production and low costs. Every step in the manufacturing schedule is preplanned and it is possible to check up at any time to ascertain whether or not the program is being maintained.

80 PER CENT COST REDUCTION THROUGH GROUP BONUS

By D. B. KIFT
General Superintendent, Edison Electric Appliance Company, Inc.

I WILL try to present a word picture of the bonus-incentive plan that has been installed and successfully operated for a number of years in the three factories of the Edison Electric Appliance Company, Inc., manufacturers of electrical appliances and equipment, known under the trade name of "Hotpoint."

To set down here the details of how this bonus is set in every department of our factory would be impossible, for our bonus-incentive plan covers clerical departments, storerooms, receiving and shipping departments, tool room, inspection department, engineering department and maintenance department, as well as manufacturing and assembly departments.

However, let us take our vitreous enameling department as an example of where it would be extremely hard to install an equitable piece-rate system, but is comparatively simple to handle under our bonus plan, from both the cost of installation and maintenance of the plan and cost reduction viewpoints.

In this department we have the making of frit, which requires

smelting and ball-mill work, pickling, dipping, spraying, wiping, drying, burning, and decalcomania transfer work on thousands of parts of different sizes and shapes, all of which entails an endless number of operations.

To set this bonus, a careful study was made of past performance over a considerable length of time. This was done to give a basis on which to work. We found in making this analysis that a more accurate figure could be obtained if pieces were converted into square feet, thereby using square feet as our bonus unit. We were then easily able to find the average cost per square foot in hours, including direct and indirect labor as well as supervision. In addition to this analysis, we made a careful study of methods and equipment, after which we were able to arrive at an allowance per square foot that was fair to both empolyee and company. When setting this rate, due consideration was given to scrap history.

This method might require modification for the average job shop, for some small parts take more labor-hours than do larger parts, due to excessive wiping and handling. We found, however, in making our analysis, that an average cost per square foot could be

FIGURE 1. *In the vitreous enameling department, unit output has increased and costs decreased under the group-bonus plan*

DAILY INSPECTION REPORT

Copies to:—Factory Cost Dept. (2)

Dept. No. 446

Date 5-1-28

Assembly Dept. 44

Serial No.

TRANSFER NO.	SYMBOL NO	DESCRIPTION	TOTAL PASSED INSPECTION	WEIGHT	GANG BONUS CONSTANT	TOTAL GANG ALLOWANCE	FOREMAN'S BONUS CONSTANT	TOTAL FOREMAN'S ALLOWANCE
13188	116F69	Iron 110V	400		3.62	14.48		
13189	115F61	Iron 110V	800		1.00	8.00		
13190	115F61	Iron 110V	24		1.00	.24		
13191	115F61	Iron 110V Sec	25		1.00	.25		
13192	116F69	Iron 110V Sec	23		3.62	.83		
64130	TE56		849		.16	1.36		
65684	F69P100	Auto. Iron	180		3.62	6.52		
						31.68		
						.74		
						12672		
					22176			
					234.432	Allowed Hrs.		
					150	Taken "		
					84	Saved "		
					= 36%	Bonus		

FIGURE 2. *In computing the bonus percentage, "allowed hours" indicates the total allotted for a given amount of work; "taken hours," to the total actually consumed in the work, including indirect labor*

used for these parts where scheduled for production in balanced sets, as every large easy part was offset by a certain number of small harder ones.

If working under job shop conditions, very likely we would find it necessary to have five, six, or possibly more classification allowances, for example: 150 hr. per 1,000 sq. ft. for flat pieces with no wiping; 165 hr. per 1,000 sq. ft. for formed pieces that require wiping; 200 hr. per 1,000 sq. ft. for cylindrical shaped pieces; etc.

Before bonus was installed, our enameling department was about as efficient as the average day-work department. From statistics it is evident that decided reduction in cost has been made over a period of years, since bonus was installed. Part of this, of course, was due to the development of more efficient equipment by our

engineers, but most of the reduction was due to increased speed on the part of the operators and the elimination of waste time. For these, undoubtedly, the bonus-incentive plan was responsible. Supervision was not changed during this period.

Members of the group are allowed 1 per cent on their total actual taken time as additional compensation for each per cent that their actual time was below the allowed time. Suppose, for example, that the allowed time for the gang was 133 hr. for 1,000 sq. ft.; the actual time 100 hr. The saving would be 25 per cent of the allowed time and a bonus of 25 per cent would be added to the day-rate of each operator for the time worked. In figuring this allowance, the total production of the bonus group or unit is converted into allowed hours at the end of a bonus period covering one month. From this allowed time is subtracted the total actual time for the same period. The difference is divided by the allowed hours, giving us the per cent of bonus to be paid to the entire group. If the department makes 30 per cent, each of the operators is paid a bonus of 30 per cent of his month's earnings in the department.

The foreman's bonus in this department was studied in the same manner, except that the figure we were after was the cost in dollars. Supervision bonus, obviously, must cover the total cost of production in a group or department in order to avoid the condition that sometimes results from less efficient methods—increased production with increased costs. It is very necessary that a foreman's allowed dollars cover day-rates and material over which he has full control.

In a department where we have long-running jobs which can be accurately timed, so far as possible we follow the same procedure in setting up allowances that we would on piece-work. The exception is for that portion of work in a department which cannot be measured on an individual basis, such, for instance, as that performed by foremen, die setters, or clerks on special jobs, etc.

In some departments, in setting up the bonus allowance we set a separate allowance for each classification of work being done, and to simplify the figuring of the bonus earned, assign a bonus constant to each classification. For instance, in the iron assembly department our standard unit, which is the iron that is assembled in the largest quantities, is given a bonus constant of one; another iron that takes more labor hours is given a bonus constant of 3.62. Figure 2 shows just how a bonus percentage is figured in this department.

Some reader is sure to bring up the argument that, in grouping all the men in one bonus, there is no individual incentive for the good worker, and that the poor worker will profit by the good worker's efforts. The answer to that objection is that the foreman sees to it that hourly rates are increased in accordance with the ability, willingness, and diligence of the employee. To avoid favoritism we keep a record of each operator's performances. This can be done wherever individual time-studies are made as a partial basis for a bonus allowance—for instance, in the punch press, machine division, and small assembly departments.

By this method of adjusting hourly rates we have as wide a variation in earnings among the different individuals in a group as we would have under piece-work, if the piece-work rates are correctly set. It is possible to have two operators doing the same class of work; one a new operator at $0.45 per hr., and the other an older and more experienced operator at $0.60 per hr. If the department makes 25 per cent bonus, for example, the $0.60 per hr. man obviously is paid a larger bonus than the $0.45 man. The operators strive at all times to increase their hourly rate by doing their work efficiently.

Setting a bonus allowance for a clerical department, such as the purchasing or traffic department, at first seems rather complicated, but as every employee we hire is employed to accomplish a certain definite thing, either individually or collectively, we found that a measure of their accomplishments could be made by a summation of these things.

Take for example, the traffic-department. The purpose of the traffic department as a group is to regulate transportation to the satisfaction of our customers, at the lowest possible cost. In this case the cost of the maintenance of the personnel was given second consideration, for this cost is obviously small in comparison with the total cost of transportation.

To accomplish our objective, we set a dollar allowance that was obtained by analyzing each shipping classification—L. C. L., express and full carload lots—the districts to which we ship and the distances involved, and other miscellaneous factors entering into the transportation cost. This analysis included the cost of operating the department itself. Note that we did not follow the usual procedure of studying the activities of each employee in the department, the reason being that we know that forced reduction in the

number of employees might result in a large loss due to improper routing of shipments.

The purchasing department, in one sense of the word, is a similar proposition, as the main objective of bonus payment in this department is to reduce inventories and the cost of materials purchased. Here, again, the cost of operating the department is of secondary consideration.

On the following page are noted a few results, other than increasing the production of employees, that have had a decided effect on the ultimate result—profits.

1. Group bonus makes thinkers out of most workers, for they know that more efficient ways of doing their work result in increased production. Many of our workmen suggest changes in dies and fixtures and sometimes changes in the design of parts, to facilitate production. They also are glad to pass on their efficient ways of doing things to less capable men in their group, and take care of the elimination of lazy and careless workers who will not attempt to hold up their end of the job.

2. Indirect labor, such as sweepers, truckers, oilers, and die-setters are always interested in seeing that everything is done to keep the operators busy, such as making sure that materials are at hand when required, equipment is kept in running condition, and parts and scrap are moved away from the machines as often as necessary to avoid interfering with the operator's movements.

3. Quality is improved, for operators know that they are paid for their good work only. The plan, for this reason, has reduced the necessity for supervision inspection.

4. Each foreman becomes a real manager of his department. Our plan, in effect, makes his department his personal business, because his personal income materially increases or decreases, depending upon how carefully he regulates production, labor, hourly rates, and the various costs of operating his department as a whole.

5. Our bonus plan permits a daily check on costs in every manufacturing department, giving the superintendent an opportunity, if costs have increased, to apply remedies where necessary before much damage can be done.

6. The cost of operating this plan is much less than was the cost of operating our former day- and piece-work plan.

7. Lastly, we are sure that our wage-payment plan is a decided factor in maintaining our highly efficient organization. Our em-

ployees cooperate with each other throughout the entire company. Through this cooperative spirit and the coordination of our efforts, we attain the final result—profits.

Now let us summarize and see just how close our plan comes to meeting the eight essentials of the ideal plan as noted at the outset.

1. Our plan without a doubt does contribute to the financial benefit of both employee and employer. This was brought out in the description of the method of paying the bonus in our vitreous enameling department.

2. Our plan most certainly encourages a workman materially to increase his day-work efforts and does not have the effect of restricting production that a loosely set piece-rate would have, nor the effect of reducing an operator's output that sometimes results if a piece-rate is set too tight, thereby discouraging an operator. Under our bonus-incentive plan everyone does his best and this coordination of efforts invariably results in higher wage-payments for the entire group.

3. An employee's compensation does, as nearly as practicable, reflect his contribution to the company's success, since we see to it that the best workmen are given the highest hourly rate.

4. Without question our plan is unlimited in its application. We know of no condition under which it cannot be applied. We apply it to executives, salesmen, clerical help, and all classes of productive and nonproductive help.

5. We have found our plan flexible and have had no trouble at any time in modifying it to suit prevailing conditions.

6. The plan does promote team work. Our employees in every group cooperate, and teach each other efficient methods that increase production.

7. The plan is very simple in its operation and requires much less clerical help in its administration than did our old combination day-work and piece-work plan.

8. We are convinced after years of working on this plan that it is fair to both employee and employer. Our labor turnover is low and we note from our cost reports that the company has profited by our plan.

I might add in conclusion that our bonus-incentive plan has helped us in obtaining better plant management for the following reasons:

1. By converting all orders received to standard units, the foremen are able to estimate man-hours required for a given schedule. This lets them plan their work far enough ahead to prevent a sharp reduction or increase in labor, which at all times is costly.

2. Due to the fact mentioned in Item 1, it is very easy for a foreman to find out whether promises made can be kept.

3. Costs can be very easily pre-determined. Also, by receipt of daily reports of bonus standing, costs are more easily controlled.

4. We find that departments require less discipline, which means that foremen and supervisors have more time for planning the work and devising means and methods for reducing costs.

5. The foreman's personal bonus makes him careful to balance his high priced labor with inexpensive labor, as the average hourly rate in his department materially increases or decreases his personal income as the case may be.

GROUP INCENTIVES—A STUDY IN COMPENSATION POLICIES

By W. R. TUTTLE
Works Manager, Edison Electric Appliance Company, Incorporated, Chicago

ONE fact stands out clearly from our experience with group incentives, and that is, if you want a man to do his best work, put him in business for himself with an incentive plan that pays, not for some single factor such as speed, but for the net result of every bit of work and thought he devotes to his job.

We pay practically our entire organization on this basis. Some of our people would conventionally be paid on piece-rates, but many of them are in work which one ordinarily would think of paying for on nothing but a time basis. The results support our conviction that it is worth while to hire the whole man, not just his strong back, for the hours he works for us. The plan has welded our men into compact, loyal, dependable groups and departments of trained effectiveness.

This plan is based on one fundamental principle—that every employee in the organization is there to contribute toward some definite result, some definite purpose. It is not always possible to measure the results of an individual's effort directly, but we can always find somewhere along the line the results toward which this

person is contributing, either individually or collectively with the group in which he works.

We measure results, and have just as many incentive rates in our organization as we have tangible results which can be measured without too many complications. Let me amplify this statement with an illustration, allegorical perhaps, but effective in bringing out the point I have in mind.

Consider, for a moment, a map of the Mississippi River and its tributaries. We can measure the flow of water from the Mississippi Valley as a whole, very accurately at its mouth, where the river enters the Gulf of Mexico. But this measurement gives little indication as to the flow of any one stream, such as the Ohio. Heavy rains in the Missouri Valley might easily keep up the flow of the system as a whole even if the Ohio were running practically dry. We can, however, measure the flow of the Ohio accurately at its mouth. And so on, right up to the last little brook, which is the last point of contribution to the Mississippi system that it would be practical to measure individually. You would run into many difficulties if you tried to measure each little spring or the little tricklets of water through the moss and grass which feed the brook.

Now let us take an ordinary organization chart. We have something very much like the river map we have just discussed. In each case, a large number of tributaries contribute to one major result, in this case total profits.

Profits are a perfectly good unit for measuring the accomplishment of the general management. But profits are not an accurate measure of efficiency of, say, the punch-press department or of some individual therein, for the general manager and his staff have a vastly greater influence on profits than the punch-press foreman and his operators. Management can make one decision which could completely wipe out exceptionally good results accomplished by the press department. Should the foreman and his help be deprived in this instance of their extra compensation, after having done a real job, just because some one up at the top has wiped out all or most of the profits? On the other hand, why pay the department a big bonus during a large-profit year when perhaps it actually did a mediocre job?

In our organization we have three main divisions contributing to our main stream—sales, manufacturing, and engineering.

You can gage the over-all efficiency of the sales division if you

measure at the mouth of the sales stream, that is, through the general sales manager and his staff. This measurement, however, would not be a true indication of results produced in any particular one of our three sales divisions. It would much more closely approximate the results achieved in that one of the three divisions handling the largest volume.

Suppose that one of these divisions handled a line which in volume amounted to approximately 75 per cent of your total business, one of the others 20 per cent, and the other 5 per cent. It is obvious that results would have to fluctuate considerably in either of the two smaller groups, particularly in the latter, to have any appreciable effect upon a total figure made up from these three divisions, whereas a radical drop or increase in sales in that department handling the greater volume would completely wipe out the effects of either good or bad work on the part of the other two. For the same reason, you would further segregate the three sales divisions into districts and in some cases down to the individual, depending entirely upon analysis of the results.

The factory group is divided in much the same manner. An over-all measurement of the plant gives an equitable basis for rewarding the factory manager and his immediate staff. The figures, however, would be of little more value than profits for measuring any one department or individual therein, as the factory manager and his staff have such vastly greater bearing on factory results than any one department. Then again the departments themselves bear a widely varying ratio to the over-all factory results, and in trying to measure the results from each department by the total results achieved in the factory you have an exact parallel of trying to measure the flow from the Ohio River at the mouth of the Mississippi.

We can in every instance, however, measure the flow from each department, giving us a sound basis for rewarding those responsible for the over-all results of that department's activities. In some instances this would include the entire personnel of that department, where the nature of the work makes it impractical to subdivide the department into groups or into individual contributions. In this contingency the individual activities contributing toward the department results correspond to the little springs and brooklets flowing through the moss and grass which feed the brook, all there and doing their share, but impractical to measure individually.

Many of our departments are further divided into groups and even down to individuals where it is possible to measure results in an equitable manner. However, we have found it practical to place only a small percentage of our organization on an individual incentive basis, as short production runs, special jobs, idle-machine time, and fluctuating schedules are continually affecting the smooth operation of individual rates. This difficulty with individual rates as well as the need for a plan with other desirable features, such as promotion of team-work, fairness to both employer and employee, flexibility and simplicity of operation, let us to devise our present wage-incentive plan with its wide range of application.

Our traffic department is a particularly good illustration of how we measure results. Just what is the purpose of a traffic department? To regulate transportation to the satisfaction of customers and to keep transportation costs as low as possible. Obviously low transportation cost is the real result we are looking for from this group. We accordingly analyzed each classification, l.c.l. shipments and full carload lots, the districts to which we shipped and distances involved, and other factors entering into the final cost. This analysis included also the cost of operating the traffic department in itself which was simply part of the total transportation costs, the real result which we were measuring.

Working along the lines of the average incentive plan, we would have studied each job in the department and the activities of the different clerks and traffic manager with the idea of reducing the personnel. This kind of analysis would probably have been disastrous. It might easily have resulted in reducing the cost of operating the department, but at the expense of a large increase in over-all transportation costs. Consequently, we are not interested in the amount of help required to operate the traffic department, except when considered as one factor of transportation expense.

Now let us take the storerooms. They offer an entirely different problem from the one we have just discussed. Our storeroom division (not including finished stock) is divided into four main sections: one handles all raw material; another section carries the large range parts; the third small parts, such as screws, nuts, washers, and miscellaneous press and machine parts; and the fourth section handles cartons and packing material. These four sections handle in the aggregate about 100,000 different items, very few of which are ever requisitioned from the storeroom in repeat quantities, or

at regular intervals. The variety was so great that we quickly found it impossible to measure the work on an individual basis. We knew, however, that we could handle the problem on the group plan, once we had determined the different factors requiring labor expenditure.

Our analysis showed four main factors—four causes of time expenditure. They are as follows: First, number of pieces handled; second, weight of parts; third, number of requisitions handled; and fourth, number of items upon the requisitions. We found a few other minor factors, but in the aggregate they amounted to not more than 2 per cent of the total and we eliminated them from consideration.

The next move was to ascertain the relative value of these factors in terms of a common unit. We found in the first section, the raw-material storeroom, that weight played the predominant part. In fact, it amounted to 80 per cent of our compound unit of measurement. Number of pieces counted for 15 per cent; the balance of 5 per cent went for the other two factors.

Quite a different condition prevailed in the second section, handling large range parts. Here the number of pieces handled played the predominating part, actually to the extent of 91 per cent. These parts are not especially heavy, but are so large that the operator can handle only one or at the most two at a time. Weight affected our unit to the extent of 6 per cent, the other two factors, only 3 per cent. So also, in the other two storerooms, each had its own individual relationship of factors.

We found a still different condition in our small-parts storeroom. Here we found that weight played practically no part whatsoever, while pieces only amounted to something like 3 per cent of our total unit. The reason for this is obvious when we consider the fact that the storeroom help handled nuts, washers, and bolts by the shovelful, often running into thousands of pieces in one load. In this case the number of requisitions and the number of items thereon told us most of our story. So we went on into the carton section, where we still had our four factors to deal with, but again in an entirely different ratio one to the other than in any of the other three sections.

Now the whole problem in establishing this compound unit of measurement in this stores division was to ascertain accurately the relative value of each factor involved. To do this, taking one

		1923									1924	
		January		February		March		April			December	
Elements	Ratio	Produced	Std. Units	Produced	Std. Units	Produced	Std. Units	Produced	Std. Units	Produced	Produced	Std. Units
Pieces	1	1,000,000	1,000,000	960,000	960,000	800,000	800,000	400,000	400,000	8,000	460,000	460,000
Pounds	6	200,000	1,200,000	150,000	900,000	140,000	840,000	400,000	2,400,000	172,8	362,000	2,172,000
Requisitions	10	16,000	160,000	20,000	200,000	10,000	100,000	18,000	180,000	17,5	21,000	210,000
Items	12	60,000	720,000	70,000	840,000	100,000	1,200,000	80,000	960,000	85,9	76,000	912,000
Total Elapsed Hours		1,400		1,450	1,435	1,435		1,425		1,39	1,410	
Total Std. Units			3,080,000		2,900,000		2,940,000		3,940,000			3,754,000
Elapsed Hours per M Std. Units		.454			.494		.487		.362			.376
Pound Equivalents Figured at Corrected Factor of ②		200,000	400,000	150,000	300,000	140,000	280,000	400,000	800,000	17	362,000	724,000
Standard Units on New Basis (See Fig 2, Curve Y)			2,280,000		2,300,000		2,380,000		2,340,000	34		2,306,00
New Elapsed Hours per M Std Units		.613			.616		.602		.610			.611

FIGURE 1. *This table shows how the bonus time units were set. Number of pounds, of requisitions and of items were reduced to time equivalents of number of pieces. Actual equivalent output was then computed for each month*

section of the storeroom at a time, we started off using the number of pieces as unity, and then estimated the relative value of weight in terms of this unit, the number of pieces. Each of the other two factors was reduced in the same way to its equivalent unit in number of pieces. This is shown in Figure 1. Then, by multiplying the total of weight handled by our weight factor, we converted weight into pieces; likewise we multiplied the requisitions and the number of items by their respective factors of relation to our basic unit, pieces, thus reducing all factors to one common unit.

We then took our total production of pieces, weight, requisitions and items by months over a period of two years and reduced them to standard units, and balanced this figure against our storeroom payroll for the corresponding period. This gave us the cost of producing standard units by months over a period of two years. At the same time we set up, by taking the total figures involved over two years, an average cost per thousand units.

Our first figures fluctuated up and down considerably from our average line of cost, as Figure 2 shows. A careful investigation of

the past history of these storerooms brought out the fact that there were no radical changes during these two years which could have caused this wide fluctuation. We then knew that the ratios we had used must be inaccurate.

It is mathematically obvious, therefore, that if the amounts of each kind of work done in the storeroom, weight-handling, number of requisitions, of items and of parts, had remained constant month by month over the period of two years, inaccuracies in our ratios would not have affected the curve at all. But our monthly production in each one of these different factors did vary widely, which meant that any appreciable inaccuracy in our ratios would cause the cost curve to fluctuate considerably. This was what actually happened.

So we went back over all the peaks and valleys and picked out the worst one for a starting place. We adjusted our ratios until that particular peak or valley had gradually blended into the line of our average cost. This was done not altogether hit-and-miss, as we

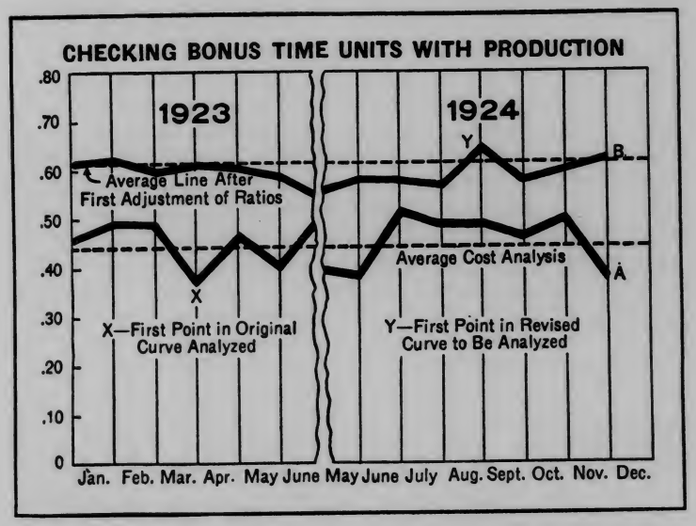


FIGURE 2. *Checking the bonus time units. Equivalent production, plotted from Figure 1, gave curve A. Ratios were adjusted to smooth the bad spot at X, giving curve B, which was smoothed at Y, and so on*

analyzed that particular period of production thoroughly, selecting that specific one of our four elements which had radically departed from the normal run of production.

Suppose that, on an average, we handled 100,000 pounds of material a month. Suppose during some particular month this figure had increased, say 50 per cent, giving us 150,000 pounds to handle. Here undoubtedly would be the logical place to find the error, in our ratio of weight to pieces. The ratio of weight to pieces was accordingly adjusted to a point which will level off that particular peak or valley; using this new ratio a new average line much more regular than before, was figured and a correction made at the point of greatest irregularity in the new curve. This process was repeated until we had finally brought our monthly production curve close to our average line. This gave us the basic figures for setting up an allowance for the department in hours per thousand standard units produced.

An over-all rate established in this manner is infinitely more accurate than the average piece-rate. In fact, in this particular instance the rate was one of the most accurate I have ever seen, and I have had experience with many forms of wage payment in the past 18 years.

The group is allowed 1 per cent on their total elapsed time as additional compensation for each per cent that they have reduced their elapsed time below the allowed time. Suppose, for example, that the allowed time for a gang for a given job was 133 hours, the elapsed time 100 hours. The saving would be 25 per cent of the allowed time, and a bonus of 25 per cent would be added to the day-rate for the time worked.

In figuring this allowance the total production of the bonus group or unit is converted into allowed hours at the end of a bonus period, which covers one month. From this allowed time is subtracted the total elapsed time for the same period. The difference is divided by the allowed hours, giving us the percentage of bonus to be drawn by the entire group. If the department makes 30 per cent, each of the operators is paid a bonus of 30 per cent of his month's earnings in that department.

This is the Rowan method of payment and while we prefer it to other methods its use is not important to the successful operation of this particular incentive plan. The group could be paid so much money for each thousand units produced as in straight piece-

work or could be rewarded by the Halsey, Taylor, or a dozen other methods of wage payment.

Prior to the installation of this bonus plan in our storeroom we had 35 men in this division. Today we never use more than 12, even though we are handling a much larger volume of business. The men in these storerooms are earning considerably more, due to their bonus, than the average storeroom help in this locality. We have a much better satisfied crew to handle and at a decidedly lower cost of operation.

In a department where we have long-running jobs, which can be measured with reasonable accuracy, our procedure in setting up allowances is the same as that followed in establishing piece-rates, with the exception of that portion of work in the department which cannot be accurately gaged on an individual basis, such as the work of the foreman, die-setters, clerks, sweepers, and other special production jobs. These portions of the departmental activities are treated in the same manner discussed under storerooms, and in combination with the above give us an accurate over-all measurement of the department.

The same units of production are used in establishing an incentive rate for the supervision of the department. However, the allowance here is made in dollars per thousand units produced. This tends to keep the day-rates in a department on a good, sound, economic basis, as a 1 per cent increase in a department's average day-rate will make a corresponding decrease in the supervision bonus. It makes a real manager out of the foreman because he soon learns that simply hiring a lot of low-grade help in order to get the average rate down is not the answer, as quality and rate of production, and department morale, are also big points to consider. He must keep all of these factors evenly balanced to reap the maximum reward. The supervision bonus plan also differs from that set up for the group, in that expense items over which the supervisor has control are included in the allowed and taken dollars.

Actual results derived from placing our supervisory help, such as foremen, gang bosses, superintendents, and others on a positive incentive basis have been far beyond our original expectations and we believe this is one of the strongest points in the plan.

The flexibility of the plan has been utilized to the fullest extent, as we have molded and modified it to suit the particular department under observation rather than change our plant to fit some cut-and-

dried routine. We have no two groups set up on exactly the same basis, although the method of analysis is practically the same.

Some departments are penalized heavily for materials spoiled in process, while in others we have found it unnecessary to consider this factor.

Our inspection department is operating 100 per cent on incentive, but naturally factors are considered that would not enter into a production bonus.

Many of the departments, prior to the installation of this plan, were operating on a piece-work basis; however, in every case the substitution of this plan has resulted in appreciable savings for the company and more money for the operators.

Below are tabulated a few of the incidental results of the plan, as years operation have forcibly impressed them upon us:

1. It unifies the purpose of all employees in the group, making each man interested in every other man's output and quality.

2. The plan eliminates drones by making the loafer and staller unpopular with the gang.

3. It causes the brightest and most experienced workers to share their knowledge with those less gifted and experienced.

4. Ingenious contrivances and kinks remain the property of the group instead of being carried away as secrets of the inventor, who on leaving the company as a day- or piece-worker generally carries away with him such ideas and contrivances.

5. We find the plan brings out the latent mechanical ability of all the workers. This is not true in piece-work, as it is generally the practice to cut rates immediately, as soon as a job can be speeded up. Under our plan the employee shares the profits of his ingenuity with the company.

6. Sweepers, truckers, oilers, die-setters, and so on, are always interested in keeping productive workers going. "Keep that machine running" is heard frequently. Cost reduction becomes the goal of all workers, both direct and indirect.

7. The plan reduces supervision inspection, as each man is answerable to the group as well as to the foreman in matters of discipline, industry, good quality. Since bonus is paid for good output only, quality is improved and poor work penalized.

8. The plan gives greater incentive to careful supervision; because bonus earned by a foreman depends on his securing output

without increasing labor cost, and because the foreman must answer to his men for failure to provide materials and convenient set-up at the right time.

9. Production and size of gang are more carefully watched, as excess men reduce bonus earnings.

10. Bonus earnings at end of each month indicate closely the cost of products as well as efficiency of factory or department.

While giving us all these benefits the plan has not carried with it the hidden expenses so often associated with an elaborate system. In fact, the expense for help involved in the administration of the plan is decidedly less than formerly when we were operating on day- and piece-work.

We feel that this plan contributes largely to the unusual spirit of cooperation between the various elements of our organization, in that it has produced larger earnings both for the company and for those in its employ.

Payment based upon results, individual or collective, is not only practical but in our case has proved to be the logical plan of compensation.

WE PAY OUR WORKERS TO KEEP PRODUCTION FLOWING

By JAMES F. STILES, JR.
Comptroller, Abbott Laboratories, North Chicago, Illinois

TWO years ago, when we moved our Chicago manufacturing operations to North Chicago, 35 miles away, there was considerable change in our personnel. Many of our employees were new at their work, and it was some time before our output per worker even approached that to which we had been accustomed.

The first departments which came back to normal were those in which the workers were paid a group bonus. This fact seems to me significant. In other departments we had day-rate, piece-work, and Halsey premium. But in none of them did the excess wage bill, in some cases as high as 60 per cent at the start, so quickly decline. Though the group bonus is not as popular today, judging by convention discussions, as is the individual bonus, where it is used it seems, as a rule, to be well liked, our workers, both girls and men, foremen, and those executives who have had direct experience with

it, swear by it. In fact, three of the four groups which now work under a group bonus arrangement have been given it at their own request.

There is nothing highly scientific about our group bonus, in the sense that most people use the much misused word "scientific." The method of payment has not been worked out with elaborate time studies and mathematical formulas. Perhaps that is one of the reasons for its success. For above all it is simple: simple to install, simple to handle, simple to comprehend.

If a bonus system or any other method of payment is complicated, it becomes difficult and costly to handle and, besides, is liable to arouse suspicion among workers. Give a wage earner some simple proposition for increasing his pay in return for an increase in output and he will eat it up. Give him something that either is, or seems to be, complicated and he begins to look for the nigger in the woodpile.

What our group bonus arrangement says, in effect, to a group of workers is this: "We are already paying you, as individuals, the day- or piece-rate which conditions warrant, but there are certain things you can do as a group which will speed up production. You find out what these things are, and do them, and we'll split extra earnings among you."

It is a simple proposition in economics that two men working together can do more than twice the work of two men working alone. Isn't it equally as obvious that a number of workers who think and act as a group will produce more than the same workers thinking and working as individuals?

Ask the foreman of our granular effervescent salts department, for instance, what happens when filled bottles begin to pile up in front of one of the girls. Immediately one of the men—perhaps the one who has been operating the bottle-washing machine—will leave his work for a moment, lend a hand to get the bottles moving, then return to his job.

Flow of production, every production man knows, contributes more than any other one thing to holding down production costs, but flow of production ordinarily is obtained only at the cost of elaborate and expensive supervision. With group bonus at work the workers themselves are on the job to maintain flow of production. And this is because they know that the bonus check of each and every worker,

no matter how early in the game his own work occurs, is a bonus for finished production only.

To the man on the bottle-washing machine, or the man unloading a truck of incoming materials, a threatened jam of filled bottles is a threat to his pay check, and he acts. At the same time the girl who is filling bottles on piece-work, knows that while her piece-rate earnings may depend on her receiving a continuous supply of materials, her share of the group bonus is determined by what happens to her finished work. So she lends a hand herself, if necessary, to clear out a jam, and does not hesitate to call on one of the men to stop his work and help, because she knows that he, too, is interested in final results.

In our effervescent salts department, which handles the production and packaging of salts from start to finish, the method of computing the bonus is simply this: For every pound of product turned out, one point is credited to the department. And for every filled bottle, one point. (For samples and special work the basis is different.) The quota of the department is a given number of points per month. For every point in excess of this quota we pay one cent a point as the group bonus, dividing the total bonus equally among all the workers in the department, regardless of their basic wage or piece-rate earnings.

We adopted this bonus system as the simplest measure of results we could devise. Then we tried it out on paper for nine months, keeping careful track of what would have been the cost if the bonus were actually in force.

What are we buying with the bonus payments? Cooperation of all the workers. And since cooperation itself cannot be measured it does not seem to us highly important to measure bonus earnings with a micrometer. In this particular department, each of the men and girls earns a monthly bonus that is often around $30. They are pleased with this amount, which comes to them as an addition to their first weekly pay check of the month, and our accounts show us that the improvement in departmental results is at least as great as the pay checks indicate.

It should be remembered that the bonus payment received by any individual worker is in addition to his regular pay. And this regular pay—which for some is day-rate, for some piece-work—recognizes the individual ability of the worker, varying just as day-rate or piece-work payment would vary in any other plant. There-

fore fine shades of difference in the bonus are not needed for the sake of encouraging individual ability.

In the packing and shipping room the basis of the bonus is three points for each order handled and one point for each unit included in an order. The bonus is one cent for each point above 10,000 points per worker. A unit may be a single bottle of medicinal tablets, or it may be a previously packaged carton of 10 or 100 bottles or packages. The allowance of one point per item works out with surprising fairness, despite the range in item sizes. Likewise the three points per invoice is surprisingly equitable, though some invoices call for but one item and some are two or three pages long.

What happens if we make an improvement in our merchandising, so that items previously sold in units or in tens now go out in packages of fifty or a hundred?

Such changes, which we are constantly making, seem at first thought to work against the shipping room employees, if business continues at the same level, though shipments are in larger units, there are fewer units on which to pay bonus. What has happened is that paying a bonus on a unit basis has helped to force shipping room economies. A year ago we had four order pickers. Today, with more business, we have three. With packaging improvements the bonus fell off a bit, and when our second best order picker left us, the others found it possible to keep up with the work without hiring a new man. They are assured that in case of temporary overload an extra man can be put on, but that normally the three are equal to the task.

It would seem that the division of one former employee's bonus among the 19 other employees in a department would be scarcely enough incentive for them to take up the twentieth man's load. As a matter of fact our method of computing the bonus gives the remaining workers a split on more than just the unreplaced man's bonus. In effect they also split part of his pay too.

This is how it works.

Suppose the department handles 10,000 orders in one month, and that these orders include 200,000 unit packages. If, to simplify the figuring, we omit allowances for absences and holidays, the bonus, with 20 employees in the department is figured as follows:

Orders handled	10,000	
Points per order	3	
		30,000

Packages handled	200,000	
Points per order	1	
		200,000
Points earned		230,000
Quota, 20 men		200,000
Bonus points earned		30,000
		.01
Bonus earned		$300.00
Bonus per worker		15.00

If just the twentieth man's bonus were split among the other 19, each would get but 75 cents per month additional. Instead, the bonus of the reduced personnel works out in this manner.

Points earned, as above	230,000
Quota, 19 men	190,000
Bonus points earned	40,000
	.01
Bonus earned	$400.00
Bonus per worker	21.05

The addition of $6.05 to each first-of-the-month pay check in the department is a real incentive. At the same time there is a saving to the company for the total addition to bonus checks does not equal the wages and bonus of the worker who was eliminated. Altogether, because of this and other savings, the payroll record of this department is now running about $3,000 a year less than a year ago, with volume about 10 per cent heavier.

In this, as in the granular effervescent salts department, there is noticeable teamwork in maintaining flow of production. In the shipping room this shows itself particularly toward the end of the day. Those who work in the department know that their bonus is computed on a basis of completed shipments. Therefore as the afternoon draws to an end those whose work would count only on tomorrow's "production" may move temporarily to some other task, so that all possible shipments may be actually completed at quitting time.

Flow of production and reduction of the regular payroll are, however, only two of the gains which we can fairly ascribe to our group bonus. One very important change has been the elimination of overtime in those departments in which the bonus is paid. Our method of computing the bonus made it possible to get the workers to agree that in future overtime rates, except in the case of maintenance men, would not be paid for work outside of regular hours.

In the first place, it is understood that short absences for sickness or prearranged half-day absences for such purposes as Christmas shopping can be balanced by legitimate overtime work. But absences not so compensated are deductible, and overtime in excess of approved absences adds to the departmental quota and therefore cuts down on the bonus. Result: we seldom have overtime payments, whereas before we made this arrangement our overtime was becoming a serious problem.

Absences are deducted in figuring the bonus quota, in the following manner:

Departmental point quota 19 × 10,000		190,000
Deduction for holiday 19 × 8 hours =	152 hours	
Other absences	104 hours	
Transfers to other departments	37 hours	
	293	
Points per hour	50	14,650
Net quota for department		175,350

In this case it may be assumed that the 104 hours deduction for absences is chiefly due to the absence of two workers during one-fourth of their month. Under these circumstances the bonus earned would be divided by 18.5, not by the normal 19. If the mathematical consequences of reducing the quota for actual reduction in working hours caused by absence, and at the same time reducing the bonus divisor, are figured out, it will be seen why the workers are so willing to avoid overtime.

The result of deduction for departmental transfers is also worth noting, as it is another gain with which the group bonus can safely be credited. The foregoing computations show that when a man is temporarily transferred to another department, his time is deducted from his own department's quota, thus increasing the departmental bonus. But his absence during the transfer does not deprive him

of his own share in the bonus. Because part of the results of the quota deduction accrue to his own benefit, he is actually paid a slight bonus for permitting himself to be transferred. The result is that all the workers stand ready to fit in wherever they may be needed, with a willingness that could scarcely be expected under any other current compensation method.

Vacations, too, have automatically ceased to be a problem. Like other absences, they bring about departmental quota reductions. Therefore if a department can get along without temporary replacements during vacation time, there is a larger bonus for all concerned. As a natural result the employees in each department voluntarily work out and adhere to a mutually agreeable schedule of vacations that keeps summer production running smoothly without our having to hire temporary unskilled workers.

No claim is made that our bonus method is perfect, any more than we assert it to be scientific. But it suits the purposes well in those departments where we have installed it. In time we shall probably make wider use of it, but except in the first department, we have introduced it only where there was an expressed demand for it, because the friendliness of all concerned is the first assurance of its success. Incidentally, two of our office departments—billing, and tabulating—are operating under the group bonus, and it is likely that a third will soon be added.

To sum up our experience let me suggest these points:

1. Know what results you want your payment method to accomplish. If you are interested in building cooperation and reducing overtime, a group bonus like ours may serve well. On the other hand, this bonus does not help us in such desirable goals as the reduction in use of packing room supplies, for which other forms, or a modification of the one in use, might be suitable.

2. Let the method of computation be so simple that every one can readily understand it. Complications breed suspicion.

3. When you have a method and a basis for extra compensation planned, try it out on paper if possible for six months or a year. That is, make all payroll computations as though the bonus were in effect, but do not make any agreement with employees nor actually pay bonuses until the books have shown that the unit is sound. This precaution is especially necessary where, as in our case, each department handles a wide variety of work for which a simple unit of measure is to be found.

If these three points are heeded the group bonus system, properly administered, should be as successful in any plant of diverse manufacturing processes as it has been in some automobile plants.

INCENTIVES CUT HANDLING COSTS 9 TO 50 PER CENT

By R. E. JANSEN

General Dispatcher, Plant Transportation Department, Westinghouse Electric and Manufacturing Company, East Pittsburgh Works

BECAUSE the work involved in the handling of materials is of such a variable nature we do not ordinarily think of it as being particularly adaptable to incentive methods of wage payment. In the East Pittsburgh Works of the Westinghouse Electric and Manufacturing Company, however, this notion has become obsolete and various incentive methods have been worked out in connection with this type of work which have proved to be sources of considerable economy in their application.

In the East Pittsburgh Works, effort in the past toward reduction of material handling costs has centered chiefly around methods and organization but more recently attention has been drawn to a study of labor. Cost records show that approximately 75 per cent of the total cost in handling materials is charged against labor and for this reason it constitutes one of the most fertile fields for cost reduction. In some industries it is possible to eliminate almost totally the human factor from material handling work by the installation of certain types of mechanical equipment. Such cases, however, are rare and in the average plant it is found necessary to engage quite a large group of men either directly or indirectly in this work.

The very nature of material handling work makes it one of the best fields for economy through the operation of wage incentive plans. This condition is due largely to the fact that the work is usually very scattered and hence presents some difficult problems in supervision. For instance, it is very easy for a truck operator to soldier on the job unless he is accompanied by a supervisor who can observe his work. Such transitory work does not lend itself well to supervision and is quite different in its method of administration from the average type of manufacturing job.

Difficulty in supervision was the chief reason for introducing wage incentives in the work covered by the plant transportation department of the East Pittsburgh Works. This department under the supervision of a superintendent centralizes the control of practically all the material handling work in the plant including the operation of industrial trucks, narrow-gage railway system, standard-gage railway, road trucks, passenger transportation and the maintenance and licensing of hand trucks. Such centralization has been found to be a decided asset in working out incentive wage payment plans.

In this plant certain kinds of material handling activity were already supervised in such a manner that no reorganization was necessary to make them adaptable to time study. In some cases, however, it was necessary to effect a complete reorganization of the work in order to pave the way for a wage incentive plan.

At present, all the workmen involved in wage incentive systems are working in groups. In very few cases is it feasible to place the men on an individual incentive basis. This is largely due to the peculiarity of the work. Placing the work on an individual basis requires that the activity of the workman be limited and this would counteract flexibility of supervision, which is very essential.

In order to work out an incentive plan for an individual or group of individuals there must be some way of measuring the amount of work done. This problem is really the most difficult one in connection with this line of work. In measuring the amount of work done the two important factors are quantity and distance. The problem would be quite simple if these two factors were the only variables but each of these two factors involves a multitude of other variables. For instance, materials might vary greatly as to bulk and weight; also, actual transit time in trucking work might be a small percentage of the total, compared to the time lost in delays due to elevators, cranes, traffic congestion, etc. Using weight as a basis might prove satisfactory if it were possible to weigh all the material that is handled. This plan might be worked out in plants where the material is well standardized, but in the Westinghouse plant where such a great variety of material is handled, it would be practically impossible.

Where transportation systems are in operation such as an industrial railway, tractor and trailers, industrial trucks, etc., each one has a certain unit of capacity such as a car, trailer, skid or truck bed. These units of capacity have been used as a basis for the measur-

FIGURE 1. *Shop express trucks handle all the small deliveries of material*

ment of work performed. This method, of course, involves a system of tagging, which in most cases can be worked out without much difficulty and at the same time will serve a dual purpose in aiding to identify material while in transit.

It was necessary to give all these factors due consideration before the incentive wage payment plans could be effectively placed in operation. In explaining these various plans it will be best perhaps to deal with each one individually.

The first work in material handling to be placed on an incentive basis was that connected with the handling of the lighter materials which might ordinarily be classed as parcel post.

The delivery of such material is performed by three electric industrial truckers who make periodic trips over certain specified routes which cover the entire plant. These trucks, as shown in Figure 1, are of two-ton capacity and are equipped with bodies which contain a number of different sized compartments suitable for accommodating the various kinds of material handled. Altogether there are approximately 80 stops made on these three routes and nearly every stop is provided with a specially designed bench, as shown in Figure 1. This bench is divided into two halves, one-

half being for the accommodation of incoming material and the other half for the material to be shipped out.

No attempt is made to handle shipments weighing more than 100 pounds. Each shipment bears a tag which serves the combined functions of identification, checking and measuring the amount of work performed. This tag is composed of three parts, one stub which is retained by the shipping section, a second stub which is detached by the truck driver upon delivery and the main part which always remains with the material for identification purposes.

These three truckers work together in a group and earnings are shared alike. These earnings are based upon the number of packages handled as shown by the delivery stubs collected. In order to make this plan fool-proof each trucker is required to stamp a time card at six different points on each route and each delivery stub must also be stamped on the back with a stamp which is kept at each delivery point. Each station is assigned a certain number and this serves as a check on proper delivery. As originally instituted the plan carried a penalty clause for misdeliveries but after being in operation for three years so few mistakes were recorded that this penalty was removed. One requirement however, is that each trucker must make a certain specified number of trips each day.

All of the incentive plans applied to material handling are based upon the principles involved in what is known as the "standard time system." By this method a workman is given a certain standard time limit for doing a job. If he performs his work within this allotted

FIGURE 2. *The classification shed serves as a terminal point for industrial railway cars*

time he "makes out" and is given a high rate which is approximately 11 per cent more than his previously earned day-rate. In this case the total earnings equal the high rate times the standard time hours. However, if the man fails to meet the standard time limit he loses nothing but merely gets his regular day-rate times the hours actually worked, which, of course, amounts to straight day-work.

The earnings of this group of truckers are calculated according to the following formula:

$$\text{Time allowed} = [(N \times 0.066) - H]\ 0.12 + H \text{ where}$$

N = Number of packages handled for pay period, and
H = Total hours worked by group for pay period

As soon as the result of this expression, which is the time allowed, is equal to H the group "makes out" and the members receive their high rates. In this case the number of packages required to "make out" is 400.

In this formula it was necessary to introduce an additional factor which causes a variable ratio between the earnings and number of packages handled. This factor produces a more equitable ratio between these two other factors and reduces the possibility of an unskilled laborer receiving the wages of a skilled laborer. This handling work may fluctuate considerably with very little change in effort expended by the workman.

In this plant a 21-inch narrow-gage railway system serves very much the same purpose that tractors and trailers do in some plants. A network of some 11 miles of track covers the most important shipping points in the plant. The cars are of three- and five-ton capacity and are shifted about by small locomotives of the storage battery type which are capable of pulling or pushing some 10 or 12 loaded cars.

At present, six locomotives handle the entire movement of these cars on five separate routes. A centrally located classification shed, shown in Figure 2, takes care of the transfer of all cars from one route to another. Each car is checked whenever it passes through the classification shed. This method gives valuable information concerning the movement of cars.

Preliminary time studies were made which indicated that any plan for incentive wage payment should be based upon the movement of loaded cars. This movement is very easily checked by the use of a red identification tag which bears a stub. Upon arrival at

the classification shed this stub is removed and credit is given to the proper crew for the delivery of the car. A "car checker" who is not included in any of the groups keeps a record of this car movement.

Here again the group system is operative. Each locomotive is operated by a crew consisting of a motorman and switchman. The six crews are divided into three groups of one, two and three crews each. In each of these groups there is also a route man who acts as group leader and is responsible for seeing that the proper movement is made of all cars on his route or routes.

In establishing time values for this work each group was studied individually and separate limits given for the movement of the cars. An analysis of the time studies shows the following detailed operations for the movement of a car:

1. Couple and uncouple car (performed twice per car)
2. Switch car (performed twice per car)
3. Deliver car
4. Allowance for delays (allowed once per car)

A time value is set for the movement of a loaded car, no credit being given for empties. At the end of the pay period if the total number of cars handled times the time allowed per car is equal to or greater than the actual time worked, the group "makes out" and the members receive their high rates. The net earnings then amount to the high rate times the standard time hours allowed.

In addition to the work already described on industrial railway,

FIGURE 3. *Most of the crates and boxes used in packing apparatus for shipments are delivered by this industrial railway crew*

there remains one other form of this type of transportation, which, in order to be placed on an incentive basis, required a somewhat different plan. Figure 3 shows an industrial railway locomotive which handles nothing but boxes and crates used in packing apparatus for shipment.

Here the measure of the amount of work performed is not given in terms of car movement but in number of crates delivered. This locomotive together with one industrial truck takes care of the delivery of the entire output of a box shop group which is also paid on an incentive basis. Although the locomotive crew and trucker compose a group which is separate from the group which makes the boxes and crates, they are both paid on the number of containers produced.

The earnings of this group are calculated according to the following formula:

Time allowed $= [(N \times 0.30) - T.T.]\ F + T.T.$ where
N = Number of containers delivered
$T.T.$ = Time taken
$F.$ = 0.10 = Factor allowance
0.30 = Man-hours allowed per container, including time for loading, delays, etc.

If the group "makes out," the members receive their high rate which, multiplied by the standard time hours allowed, gives their net earnings.

21 PER CENT LABOR COST REDUCTION

By WILLIAM B. FERGUSON
Production Manager, Newport News Shipbuilding and Dry Dock Company

NOW that the science of management has reached an advanced stage it is time to devote more intensive study to the subject of management factors. These factors are readily distinguishable. So much fact matter is available that an evaluation of their relative importance is possible. But before an attempt is made to institute this stupendous study for industry as a whole, and establish mediums through which the efficiency of management can be closely measured, it is necessary to tackle the problem in separate industries and individual plants. The present article deals with the results of such an investigation and the application of management factor

measurements at the Newport News Shipbuilding and Dry Dock Company.

The total amount of work involved in the analyses amounts to about $35,000,000, spread over a period of a little over five years. Fifteen freight and passenger ships were built during this period, including the two largest merchant vessels ever built in America—the S. S. "California" and S. S. "Virginia" for the Panama-Pacific Line—costing the owners about $7,000,000 each. The "Virginia" is an improved "California," being two per cent longer (612 feet against 600 feet), and is the largest merchant ship ever built in an American yard.

During approximately the first four years of the period under consideration, a net improvement in labor costs of about 15 per cent was accomplished. As a result of careful analysis of betterments made it was estimated by a number of executives that about 59 per cent of this improvement was due to four major management factors as follows:

Material control	21 per cent
Cost budgeting and control	13 per cent
Wage incentives	13 per cent
Planning and scheduling	12 per cent
Total	59 per cent

We find that this estimate was not so far from the truth, being only about 10 per cent too optimistic.

Since that time, that is during the past year or thereabouts, there has been a still further improvement in labor costs on ship work of nearly 6 per cent. Additional improvements are now under way in definite form with respect to training executives and workers, standardization, extension of wage incentives, plant engineering and other factors, and we forecast with considerable confidence that another gain or improvement of 5 per cent will be made during the next 12 months.

In a little over five years, therefore, we find that a total improvement or reduction in labor costs of about 21 per cent has already occurred. There has been some improvement in material costs per "unit of work"; also some improvement in overhead per "unit of work."

At the time this article is being completed, the "Virginia" is about 70 per cent completed. She will be about 85 per cent completed

when launched. The improvement in production costs over the "California" can be determined accurately for all the steel work and for all the machine shop and other shop work, but for the "outfitting" work, after launching, we will have to make estimates.

Therefore, our figures of improvement and relative effects on the improvement of our "management factors" are subject to slight revision after the "Virginia" is completed and delivered November 26, 1928. The consensus of opinion of executives in charge of "outfitting" is that my estimate of the effect of the factors "Material control—f_1 and "Wage incentives—f_3" is somewhat too low.

In selecting just twelve factors which go to make up factory management, out of perhaps twice that number which might be named or used, we deliberately selected for management factors such terms as would be essential in some degree for almost any form of management. Each of these can be expanded or extended in scope, as new features of modern management may be introduced into a plant.

Furthermore, the "factors" are limited to definite and concrete management methods, procedures and recognized practices, conforming to management laws or principles agreed upon by authorities

	MANAGEMENT FACTORS "f"	Total Cumulative Per Cent Improvement-1923 to 1928											IMPROVEMENT THROUGH
		1923	1924		1925		1926		1927		1928		
		July 1	Jan. 1	July 1	Jan 1	July 1	Jan 1	July 1	Jan 1	July 1	Jan. 1	July 1	
		0.4	1.4	2.5	4.0	6.0	8.0	10.5	13.0	15.7	18.4	21.0	
		Per Cent Improvement Shown by Each Factor											
1	Material control	10	30	36	43	50	57	63	70	77	85	93	
2	Cost control	—	—	20	30	40	49	58	67	76	85	93	PRODUCTION CONTROL
3	Incentives	—	—	10	20	30	40	50	60	70	80	90	
4	Planning and scheduling	—	2	4	7	10	24	38	52	66	80	90	
5	Design	—	—	—	—	5	18	31	44	58	73	87	
6	Employment	—	—	—	—	—	—	—	—	15	40	70	INDUSTRIAL RELATIONS IMPROVEMENT
7	Plant engineering	—	—	—	—	—	5	20	35	50	65	80	INCLUDES MECHANICAL HANDLING
8	Purchasing	—	—	—	—	5	18	31	44	58	73	87	
9	Inspection	—	—	—	—	—	5	20	35	50	70	85	
10	Storekeeping	—	—	—	—	5	10	15	20	30	55	85	
11	Standardization	—	—	—	—	—	—	5	20	35	55	75	
12	Timekeeping	—	—	—	—	—	—	—	—	—	10	40	

FIGURE 1. *Management Factors: Total cumulative per cent improvement in each factor in 5 years—1923 to 1928. The end of 1928 is taken as 100 points —not shown on the chart*

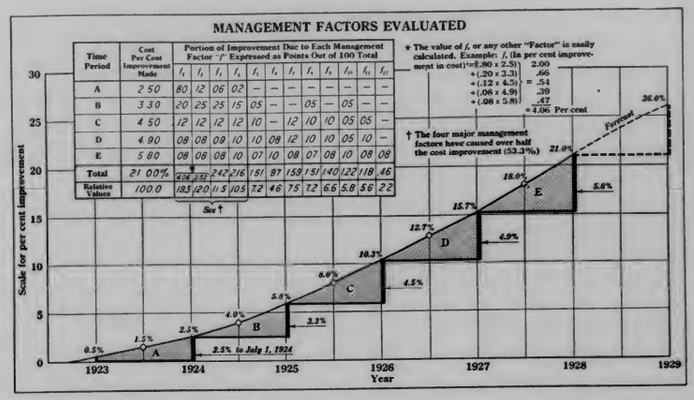


FIGURE 2. *Evaluation of management factors showing a 21 per cent reduction in labor cost in 5 years*

or successfully applied throughout manufacturing industries. For example, the terms "material control" and "planning and scheduling" are used, dealing with definite tangible things—predetermining (for example) the continuous "flow of materials," properly grouped, listed, and constantly checked—through successive stages and operations all the way from raw materials to finished final assemblies. Pre-planning for labor is equally important. These terms are much to be preferred to "production control," which for our purpose is too general and too comprehensive a phrase; and although used for years in literature on management, it is a poor phrase to use in technical discussions of this sort.

Factory management aims to produce goods (ships, shoes or soap) at lowest manufacturing cost, of best commercial quality for purposes intended, and in a definite time. Sales and production must be coordinated, of course, by using such management factors as planning and scheduling, incentives, etc. Coordination is an abstract result, and not a specific management factor.

Before describing the quantitative method used for "evaluating" all major management factors in large scale manufacturing, such as ships, we will first state our twelve factors, with such subheadings as may be needed for any extension of the scope or meanings thereof, as time goes on. Then we will add, for each factor, a few notes as

to when definite improvements or betterments were started, since January, 1923, that being the zero point for our observations and calculations:

Factor 1 (f_1)—Material control. Specific improvements first inaugurated early in 1923, by arranging all material parts in logical sequence groups. Next radical step taken in October, 1923, with the formation of a central material control committee. The third big improvement was centralizing the work of material distribution in May, 1927.

Factor 2 (f_2) — Cost budgeting and control. Improvements started early in 1924 are still in progress. A new cost control system put into effect in July, 1924, has been extended and improved from time to time.

Factor 3 (f_3)—Wage incentive systems. In January, 1923, only about 15 per cent of our working forces were on any wage incentive plan, 85 per cent of our labor being day-work. In June, 1924, definite plans were started for further extension of incentive systems, including piece work, bonus and premium methods. At present over 60 per cent of our workmen are on some incentive plan, also a large portion of our service departments.

Factor 4 (f_4)—Planning and scheduling. Improvements in forecasting and planning, for both material and labor, followed the improvements in Factors No. 1 and No. 2. The summer of 1926 found us in shape to concentrate still further on detail planning.

Factor 5 (f_5)—Engineering and design research and development. The improvements in this factor have been steady and consistent.

Factor 6 (f_6)—Employment of labor; training of executives and workers. In January, 1927, this work was concentrated in the department of industrial relations. There is a great field ahead for intensive shop training, with full-time instructors.

Factor 7 (f_7)—Plant engineering and equipment. From 1922 to 1927 plant expenditures for new equipment were kept to a minimum, the plan being to improve other factors first, and get the most out of what we had. Improved processes and extension of welding in place of riveting are included in this factor. We have extended our plant facilities for woodworking very considerably during the past year, and expect other plant improvements to go on steadily.

Factor 8 (f_8)—Purchasing methods. Improvements steady, and dependent on other factors.

Factor 9 (f_9)—Inspection; quality control. Improvement in in-

	SPECIFIC APPROACHES	MANAGEMENT FACTORS												TOTAL POINTS
		Material control	Cost budgeting and control	Wage incentives	Planning and scheduling	Engineering and design	Employment and training	Plant engineering and equipment	Purchasing	Inspection	Storekeeping	Standardization and simplification	Timekeeping	
		1	2	3	4	5	6	7	8	9	10	11	12	
1	Production control	9.	—	—	2.2	—	—	—	—	—	—	—	—	11.2
2	Inventory control	—	—	—	2.0	—	—	—	2.0	—	5.0	1.0	—	10.0
3	Quality control	—	—	1.0	—	1.0	1.0	1.0	1.0	4.3	—	—	—	9.3
4	Improved equipment	—	—	—	—	—	—	9.0	—	—	—	—	—	9.0
5	Coordinating sales and output	—	—	2.0	5.0	—	—	1.6	—	—	—	—	—	8.6
6	Budgeting	—	6.5	—	—	—	—	—	—	—	—	—	—	6.5
7	Research	—	—	—	—	6.5	—	—	—	—	—	—	—	6.5
8	Simplification and design	—	—	—	—	5.0	—	—	—	—	—	1.5	—	6.5
9	Cost accounting	—	2.5	—	—	—	—	—	—	—	—	—	3.1	5.6
10	Mechanical handling	—	—	—	—	—	—	5.2	—	—	—	—	—	5.2
11	Wage and incentive plan	—	—	3.7	—	—	—	—	—	—	—	—	—	3.7
12	Labor management	—	—	1.2	1.2	—	1.2	—	—	—	—	—	—	3.6
13	New or bettered plant, buildings, yards	—	—	—	—	—	—	3.2	—	—	—	—	—	3.2
14	New or substitute materials	—	—	—	—	1.3	—	—	1.3	—	—	—	—	2.6
15	Hiring and training	—	—	—	—	—	2.6	—	—	—	—	—	—	2.6
16	Welfare and safety work	—	—	—	—	—	2.0	0.6	—	—	—	—	—	2.6
17	Employee stock ownership	—	—	1.0	—	—	0.5	—	—	—	—	—	—	1.5
18	Power generation and transmission	—	—	—	—	—	—	1.2	—	—	—	—	—	1.2
19	Employee representation in management	—	—	—	—	—	0.6	—	—	—	—	—	—	0.6
	REMARKS	The above relationships and estimated distribution are for illustrative purposes only, accuracy not claimed.												
A	Total of above-as estimated by 303 plants in 23 industries	9.0	9.0	8.9	10.4	13.8	17.9	*21.8	4.3	4.3	5.0	2.5	3.1	100.0
B	Total as estimated by 67 executives in shipyards †	21.0	13.0	13.0	12.0	10.0	7.0	7.0	5.0	5.0	4.0	2.0	1.0	100.0
C	Total as tabulated in figure 2	19.3	12.0	11.5	10.5	7.2	4.6	7.5	7.2	6.6	5.8	5.6	2.2	100.0
D	Forecast for next 2 years	10.	10.	10.	10.	5.	15.	10.	5.	5.	10.	5.	5.	100.0

* In regular "Manufacturing" improved equipment and tools play a greater part than in shipbuilding where field work and hand work greatly exceed the fabricating or shop work done by machinery, the ratio being about 5 to 4 in favor of "manual" labor.
† Published in Nov. 27 issue of Manufacturing Industries.

FIGURE 3. *Relationship between "specific approaches" and "management factors"*

spection methods has been gradual, with an important change in organization and product inspection about a year ago.

Factor 10 (f_{10})—Storekeeping; inventory control. Most of the improvements in this factor have been made during the past year, including a reduction of inventory or stock of about 40 per cent.

Factor 11 (f_{11})—Standardization and simplification of design. Improvements started nearly three years ago have continued steadily.

Factor 12 (f_{12})—Timekeeping; cost accounting. Improvements and changes in timekeeping methods are less than a year old. These should continue steadily.

In previous articles, the critical dates were shown in chart form, but a portion of this information is reproduced in the accompanying illustrations in tabulated form.

TABLE 1

PRODUCTION INCREASES IN TWELVE INDUSTRIES

Manufacturing Industry	Production Increase Percent	No. of Companies	No. of Employees	Relative Weight or Size
Boots and Shoes	− 3.2	3	1,681	1
Cement	+ 32.0	120	35,000	21
Iron and Steel	+ 18.2	12	23,451	14
Machine Building and Metal Working—S.	+ 30.0	43	60,046	36
Automobiles	+ 19.5	4	14,427	8
Castings—S	+ 13.5	9	5,253	3.5
Forgings—S	+ 30.1	4	2,249	1.5
Sheet Metal Products	+ 12.9	7	3,639	2.5
Special Machinery—S	+ 2.4	3	4,731	2
Paper, Pulp and Paper Products	+ 18.7	15	7,387	4
Textile: Cotton and Woolen Fabrics	+ 3.2	6	6,087	4
Woodworking: Furniture—S	+141.2	12	3,852	2.5
Total	.....	238	167,800	100.0
Weighted Average	+ 27.3 Increase in 4 years, or about 7 per cent a year.	.....	Abt. 700	

Why is it valuable and important for an industry or an individual concern in any industry to obtain a reasonably accurate picture or perspective as to the relative value of all major management factors toward cost improvement: First, with respect to cost improvements in the past and up to the present; and next, with respect to future

plans and forecasts of possible cost improvements? These questions almost answer themselves. Management to be intelligently directive must have a sound basis for directing the potential energies and thoughts of all executives and supervisors and workers along those paths that promise the greatest returns. Management must also know and appreciate the best, most gainful sequence or order of instituting better methods, that is, what management factors can be improved first, before changes on others should be attempted. How many can be improved simultaneously, and so on?

Which factors should receive the most attention by the best minds and talent in the plant, then which should come next? Which are the most difficult to improve, and why? Which factors are most easily comprehended, hence can be fairly well handled by minor executives, under proper guidance? Which factors can be improved merely by exercising "authority" and brains, and which ones take a long period of education, salesmanship, or training?

None of these queries can be correctly answered by the management without something better than mere "hunches" or hasty opinions,—for opinions worth acting upon must be based upon good judgment and sound reasoning. Good judgment by good judges must always be based upon sound evidence, upon reliable, authentic information, upon intelligent analysis and interpretation of facts and figures, and upon a careful weighing of all the evidence and facts.

Speaking more concretely, from the recorded experience and reliable facts set forth in these articles about shipbuilding (which embraces many industries in itself), as well as from similar recorded experience in repetitive manufacturing on a large scale, we can confidently place material control as the first management factor to get organized in a new plant just starting to produce, and as the first factor to start improving in an old plant, when the management first makes up its mind to put on an active betterment program.

It would be folly to start incentive systems before good material control, including a proper flow-of-work, was fairly well established. This major predominant factor in turn must be tied in with detail planning and scheduling. Better control of quality of work—which is a result of improving several management factors (inspection, engineering and design, plant engineering, purchasing, etc.)—is a continuous process, from the very inception of any betterment

program, but the progress achieved will depend greatly upon material control, as well as upon training and quality incentives.

It may be interesting to compare the mathematical results which were worked out for shipyard, as described above, with somewhat similar information obtained from 303 manufacturers engaged in 23 industries throughout the United States, and reported in graphic form in the June, 1928, issue of *Factory and Industrial Management*.

The headings under "specific approaches," such as production control, inventory control, budgeting, wage and incentive plans, etc., are similar to and in many cases identical with the "management

TABLE 2

RELATIVE MAN-HOURS ON A FREIGHT AND PASSENGER SHIP

Industry (or Trade)	Shop Work or Fabricating	Field Work or Installation on Ship	Total
Steel Work and Hull Fittings	52,000	135,000	187,000
Electrical Work	3,000	8,000	11,000
Woodwork:			
Joiners	45,000	55,000	100,000
Ship Carpenters	2,000	12,000	14,000
Machine Shops, Boiler Shop and Forge Shops, Castings and Forgings, Etc	140,000	.....	140,000
Installation of Machinery	.....	42,000	42,000
Plumbing and Piping	10,000	30,000	40,000
Sheet Metal Work	5,000	10,000	15,000
Painting	5,000	35,000	40,000
Riggers and Laborers	.....	24,000	24,000
Drafting and Pattern Shop	52,000	.....	52,000
Transportation and Miscellaneous Departments	1,000	34,000	15,000
Total	315,000	385,000	700,000
Ratio	45%	55%	100%

factors" which we have used during the past year in these articles. There is, however, an essential difference in several cases in the phraseology and meaning of terms, as will be pointed out later.

For comparative purposes it is interesting to note that of the 19 "specific approaches" to the four general problems of management, we find that there are five major "specific approaches" (namely,

production control, inventory control, quality control, improved equipment, and coordinating sales and output) which figure out, from the data charted, to be nearly 50 per cent of the entire 19 "specific approaches" in relative importance. That is, the five major items are about as important as all the remaining 14 items combined. Then we find that the next five "specific approaches" in relative importance amount to 30 per cent of the grand total in relative value; and that the remainder of the "specific approaches," nine in number, embrace the remaining 20 per cent of the grand total in value or importance.

The above average or composite answer to the "management factor" problem, which we have worked out quite differently for our shipbuilding plant, is extremely interesting and corroborates to an extent the demonstration that our four most important management factors—material control, cost budgeting and control, wage incentives, and planning and scheduling—have affected the problem of cost reduction more than all other management factors put together. Material control, plus planning, scheduling and dispatching, as described in previous articles, together constitute what is usually termed "production control."

The relationship between the "specific approaches" mentioned and our "management factors" is set forth in chart form in Figure 3.

Here we have shown approximately the relationships between "specific approaches" from the June issue of *Factory and Industrial Management* and our "management factors"; and from our approximate estimates of the relative distribution between the two terms, have indicated at the bottom of this chart the relative values or evaluation of management factors by the two methods (A and C). Method B is also shown, taken from independent estimates of 67 shipyard supervisors.

Method C, or the mathematical method, is considered fairly accurate for our shipyard during the 5½-year period just ended. The ratios or "relative values" of management factors in cost reduction for any period can be worked out in the same manner. Our forecast of these ratios for the next two years, in Figure 3, is naturally quite different from the ratios in Method C, for the previous 5½ years.

In making these studies and calculations covering a long period of time, for a very diversified and composite industry, we have had

in mind the great difficulty of the task and the possibility of errors. The analyses, however, step by step, lead us to a fairly correct perspective of the whole problem; and our experience and results in this complex industry further teach us that management factors can best be studied and improved in logical dependent sequence, for permanent and continuous benefit to all concerned.

During this 5½-year period, beginning with improved material control, while labor costs have been reduced 21 per cent by better management and methods, resulting in increased output per man, the workers have also benefited in increased earnings to the extent of 12 to 13 per cent. Our quality of work has also improved and the customers are getting the benefit of this improvement.

Comparing the progress in Great Britain in respect to output per man during the period 1907 to 1924 inclusive, or 18 years, we find from the reports of the special committee on the subject, termed the Balfour Committee on Industry and Trade, that the productivity per man in this 18-year period had increased to but a relatively slight extent.

> Apparently enlargement of mechanical power and improvement in technical processes have done little more than compensate for the reduction in hours of work. Costs of production of goods in industries were found to have been notably increased. Both these conclusions apply apparently more to the export industries than to those operating mainly for the domestic market. The costs of distribution, as revealed in the margin between producers' prices and consumers' prices, seem to have been substantially increased. (*Saturday Evening Post,* June 7, 1928.)

Here are some more figures that may be of interest in comparing shipbuilding productivity per man in the United States and Great Britain, from fairly authentic data at hand. Comparisons made between the output per man in British and American yards in building combined freight-and-passenger ships show that the output per man last year in British shipyards was only 59 per cent or 60 per cent of the output per man in American shipyards. A similar comparison for all industries in the United States and Great Britain was published last May by Ralph G. Couch, in which he estimates from Department of Commerce data that the output or productivity per employee in Great Britain is only 60 per cent of that in the United States.

WESTERN ELECTRIC GROUP BONUS METHODS

By W. F. HOSFORD
Western Electric Company

THE present prosperity of American industry is without doubt due in a large measure to the successful reduction of costs achieved by our industrial leaders through the adoption of more efficient methods of manufacture, the development of labor-saving machinery, and the introduction of wage-incentive plans for increasing the productivity of labor. While the last of these elements is perhaps the most intangible one, the great importance of more efficient utilization of working time is readily apparent when we consider the enormous yearly labor and overhead charges of our larger industrial concerns.

One of the very favorable features of the wage-incentive method of decreasing costs by increasing production is that both the employer and employee gain through the increased productivity. We all know that an increase in production reduces the overhead or loading cost per unit, and consequently it is possible by increasing production to reduce manufacturing costs, even though the direct labor cost per unit remains the same. In fact, where expensive machinery is employed, it might even be economical to pay higher unit labor rates in order to increase production beyond certain levels.

The problem of wage payment is one of the oldest which confronts any line of commercial endeavor. In the case of day labor, the employee sells his physical and mental efforts for a predetermined wage, which is based on prevailing labor conditions, his skill and experience, and the class of work for which he is hired. To establish the most equitable wage, the relationship between effort and its compensation should be constant, so that as the employee increases his value to the management, his wage increases in direct proportion. Obviously, a wage scheme which provides this relationship is of the greatest benefit to the employer and employee alike, because the incentive for increased production is unlimited.

While wage payment on a straight day-work basis is necessary on certain classes of work which do not lend themselves to the application of incentives, it is *satisfactory* only for the type of work which attracts employees who are far-sighted enough to be stimulated by the expectation of a reward at a rather remote time. For

the average worker, however, the day-work system usually fails to stimulate production to an economical point. For this reason, the Manufacturing Department of the Western Electric Company operates very largely on an incentive basis, piece-work being the plan in general use.

Our manufacturing department at the Hawthorne and Kearny Plants employs approximately 24,000 people, occupies over 3,100,000 sq. ft. of floor space, and produces annually over $128,000,000 of manufactured product. All of the better known processes and mechanical operations are performed, as well as a very large number of special and unusual processes. The product manufactured consists of some 13,000 kinds of apparatus, requiring over 110,000 different parts.

In the operation of a manufacturing unit of such size and variety, it would not be practicable to employ any one type of wage payment, except possibly day-work. Our policy has been to use whatever plan will best fit the particular job, and through the standardization of methods and operating conditions, we have been able to apply some form of incentive to over 85 per cent of our productive labor. We have also succeeded in placing approximately 23 per cent of our indirect labor on an incentive basis.

An important fundamental step in the application of incentives to the numerous phases of our manufacturing activity is the establishment of labor grades, or base rates, which are used as the basis for the incentive rates. All hourly rated occupations are classified into clearly defined grades in accordance with the class of work, the skill required, and corresponding conditions in the local labor market. Each of these grades covers a limited range of hourly rates, and is used both as a basis for rating new employees and for re-rating experienced employees in accordance with their increase in ability and value to the company. Workers who remain in the same class of work are re-rated at intervals within the range of the grade. This standardized grading of labor assists in maintaining uniform labor costs and provides a ready means of classifying new jobs.

Before we go farther, let us consider a few of the factors that must be kept in mind when determining the most feasible wage plan to use for a given set of conditions:

1. The plan must be sufficiently flexible to cover any jobs that may occur within the class of work involved, considering the period within which delivery may be required, the supply of work, and other factors of production outside the control of the workmen.

2. Compensation to the individual employee must be as nearly uniform as possible for all payment periods, and so far as possible should be in direct proportion to the effort put forth.

3. Payment for work should be made as soon as possible after completion.

4. The plan must be simple enough to be easily understood by the workmen.

5. A grading system must be provided whereby the employees are classed according to skill and are assigned a definite grade of work, so that they may receive compensation in accordance with their grade of skill.

6. The methods used must be as well standardized as possible, and the system of measuring output must be such that it lends itself readily to time standardization and consistency between different jobs and classes of work.

7. The cost of operating the plan, that is the counting, crediting, inspecting, and rate-setting expense, should be within reasonable limits.

8. Where possible, the direct supervisors should share in the incentive provided for the workmen, to stimulate closer cooperation in maintaining high standards of performance.

We have found that while certain classes of our work are particularly suited to one type of incentive wage plan, for other classes an entirely different plan is required. Consequently, as a result of our diversified activities, we have in use at the present time, in addition to day-work, a number of different incentive wage plans, some of which differ from each other in minor characteristics only. These wage plans are individual piece-work, gang piece-work, gang premium, tasks, and efficiency rating scheme, which is applied to some of our day-work jobs.

Individual piece-work, with guaranteed day-wage is that type of piece-work in which a definite price per unit is established for an operation or combination of operations performed by a single employee. The employee receives the piece-rate per unit multiplied by the number of units completed, regardless of the time consumed in doing the work, except that should the employee fail to earn an amount equal to his day-rate for the week, he is paid a guaranteed wage. Under all of our incentive plans, the day-rate is guaranteed. Under the individual piece-work plan, the piece-rate is so established that when average piece-work output is produced, the return to the operator is 125 per cent of the base rate for that class of work, the total wage being in all cases directly proportioned to the output produced.

Individual piece-work is best adapted to operations which can be performed by one employee, to classes of work on which each

employee's production is easily segregated, and to those jobs which require inspection after each operation. It is the most direct form of incentive, in that the earnings of the operator are in direct proportion to his individual output. This provides the highest degree of incentive, and the application of this type of piece-work is therefore particularly desirable for jobs having a high ratio of overhead cost to labor cost.

It is an established fact, however, that individual piece-work is thoroughly successful only when a steady flow of work involving very little interruption is available, and on work which can be definitely outlined in such a way that each operator performs only those tasks for which he is paid by the piece-rate. Those jobs on which the work of various operators overlaps, or on which operators are dependent upon each other in performing a total task, are more adaptable to group compensation plans.

The group wage incentive, or "gang piece-work" as we call it, is the term applied to that form of activity in which the efforts of two or more employees are combined in building up a common output unit or group of units, and in which each employee shares in the resulting earnings in proportion to his hourly rate.

Theoretically, "gang piece-work" is best adapted to classes of work where the individual's efforts are not readily segregated, or where a number of operators are dependent upon one another for the attainment of maximum output. It offers a monetary incentive to groups of workers for maintaining higher standards of productivity and high quality, which in some cases can be attained only through close cooperation between the members of each group. It may also be applied to classes of work in which the functions of the group are not directly related, and in such cases a spirit of competition between the groups enters into the scheme, acting as a stimulus for increasing production.

The grouping of employees on certain classes of work possesses advantages over the individual incentive plan where a combination or sequence of operations is necessary for mass production. Under these conditions, the group plan not only lessens the expense of inspection, but also provides a means of including miscellaneous indirect functions which influence the group productivity, such as porterage, tool and machine maintenance, supervision, instruction, preliminary inspection, and repairing.

Our first conception of the group idea came about in connection

with assembly work, in which a number of successive operations on partial assemblies are required in building up the final assembly of a piece of apparatus. The satisfactory results that have been obtained through the cooperation stimulated among the employees, the flexibility of the plan, and the simplicity of its operation, however, have resulted in its gradual expansion, until it now embraces over 60 per cent of our productive workers who function on an incentive basis. This includes such activities as woodworking, ironworking, wood and metal finishing, winding, stranding, wiring, assembling, adjusting, and many others.

Under the gang piece-work plan, all employees participating in the gang are assigned hourly rates in accordance with the labor grade class in which they are placed and are guaranteed this rate for the number of hours worked. The gang piece-rates are established on the basis that the employees working at normal efficiency should earn at least 125 per cent of the day-work value of the time credited.

The problems encountered in the various organizations in which this form of piece-work is used are necessarily different, and, in consequence, the gang plan has been set up in these four forms to meet the variable conditions encountered:

1. Weekly gang piece-work
2. Bi-weekly gang piece-work
3. Monthly gang piece-work
4. Gang premium

There is a similarity in the first three forms, in that each is modeled so as to provide payment at the end of the period designated for the work performed during that period, but since the average job in various classes of work requires a varying length of time for completion, the three different payment periods are required in order that the work may be accurately credited. These four forms of group incentives may be defined as follows:

1. Weekly gang piece-work is applied to that form of activity in which a group of employees works together in producing a class of work that requires less than one week for completion of the average job.

2. Bi-weekly gang piece-work is applied similarly to classes of work which require less than two weeks and more than one week for the completion of the average job.

3. Monthly gang piece-work is applied to classes of work which require less than one month and more than two weeks for the completion of a normal job.

4. Our application of the gang premium plan is confined to that form of activity in which the employees depend largely upon the output of automatic machines for their compensation. The earnings of each group under this plan depend upon its ability to keep the machines which they operate producing as nearly 100 per cent of the time as possible.

A number of elements under the control of the operators directly influence both the quantity and quality of production, such as the proper care of tools, accurate gaging, stocking up the machines, and miscellaneous machine attention, such as oiling. Under the gang premium plan, the rates are established per machine and take into consideration the speed of the machine, its normal productivity (deducting normal machine idle time), and the amount of attention time required by the group per machine. These rates, as the name implies, are premium rates and apply only to the parts produced per machine-hour over a predetermined required hourly output. In this manner, the workmen are given their day wages up to the point of the premium "starting output," and premium earnings for all parts produced by each machine in excess of that figure.

Each group of employees operates a number of machines, the average number of machines per employee in the respective groups ranging from one to seven, depending upon the kind of machine, the material being worked on, and the manufacturing tolerances required. By virtue of the premium method, the employees are protected in case interruptions beyond their control result in one or more machines becoming inactive. Should an employee be operating four machines and normally receiving 28 per cent balance, the break-down of one machine would not cost him 25 per cent of his earnings as in the case of piece-work, but only one-quarter of the premium earnings, or about 5 per cent of the total wage, because each machine earns a separate premium for the group by which it is operated.

The gang premium system, in general, is adapted to the same classes of work as gang piece-work, but is used only where machine activity is of prime importance in determining the earnings of the operator.

Practically speaking, aside from the premium plan, there is very little difference between our various types of gang piece-work, except in the method and period of crediting the work. Therefore, since the monthly gang piece-work plan is the one we use most, and is quite representative of the others, I will describe it in more detail.

In building up a piece-work gang or payment group, all employees contributing toward a common unit of output are organized into a gang under the supervision of a gang chief. In cases where the work involved is such that certain functions interlock or are common to several groups, the groups in question are combined into larger gangs under the supervision of section chiefs, and these in turn may be combined into a still larger gang, which in many cases involves an entire operating department. For instance, our loading and repeating coils department at Hawthorne consists of four sec-

tions and thirteen gangs, involving 362 productive employees. The department is supervised by a foreman and two assistants, and is served by 30 non-productive workers, such as line supervisors, porters, stockmen, and process inspectors, bringing the total personnel to 395. The functional split in the organization is made by general classes of work, such as winding, finishing, and assembly.

Because of the interlocking relationship of the various group functions, all of which contribute toward the production of the finished loading and repeating coils, for which the department as a whole receives payment, this entire department, with the exception of the foreman and assistant foremen, is set up as a single piece-work gang.

The time required by the individual or group to perform each operation or combination of operations is calculated from previously established time standards, which are developed from a study of the fundamental laws governing the time required for each class of work. If no time standard is available, an individual time study is made.

Operation or unit rates are then set up, showing the time required to complete each component part of the total job. A summation of these units, plus certain allowances, when converted into money by means of the various labor grades, represents the gang piece rate.

The allowances referred to cover non-productive functions, included as a percentage of the whole, after the job rate has been set up, and cover such elements as supervision, tool and machine care, the instruction of new employees, the making of small quantities, the repairing of defective parts, and porterage. This stimulates the non-productive to aid as much as possible in maintaining high productivity.

Our application of these non-productive allowances varies on different classes of work, but three factors for which allowances are made in all of our gang piece rates are personal time, training, and supervision.

All of our piece-work rates include a five-minute allowance per hour for the employee's personal needs, that is, the net production per hour is based on actual working time of 55 minutes per hour.

The allowance for training covers the inefficient work of new employees until they have reached a point of average productivity. in training at one time and the average time required to bring the This allowance figure is based on the normal number of employees

new employee to the point of normal productivity, which naturally varies for each different class of work. Using a constant figure in this manner is, of course, not the most accurate way of doing it, but with the average allowance in the neighborhood of 3 per cent, we find that fluctuations above or below this average have no appreciable effect on the piece-work earnings. New employees, however, do not participate in the gang piece-work earnings until they have been with the company for a period of two weeks. During this time, they are given a straight day-wage.

Gang chiefs and section chiefs who participate in gang piece-work earnings must necessarily perform a number of non-productive functions, such as the assignment of jobs, making out time credits, checking the quality of work, making minor machine repairs, and numerous other personnel and statistical functions which are an essential part of the supervisor's job. This allowance in each case is expressed as a percentage figure of the total piece-rate, and covers only the percentage of supervision that is necessary for successful operation.

The total piece-work value credited to a gang at the completion of the payment period is determined by a summation of the job earnings during that period, the credit on each job being found by multiplying the number of units produced on each job by the rate per unit.

To show how the earnings are distributed among the workers in a gang at the end of a payment period, we shall consider a typical case involving a gang of 20 employees who are working under the monthly gang piece-work plan. Let us assume that the gang of 20 workmen accumulated a total earnings' pool of $3,160 and that the day-work value of the time credited amounted to $2,340. The difference between the day-work value of all the time credited and the total piece-work earnings amounts to $820, which is termed the piece-work balance. Dividing the $820 by the day-work value, we find that the piece-work balance is 35 per cent. Each employee in the gang then receives his pro rata share of the piece-work balance, or 35 per cent in addition to his hourly rate. To illustrate, let us take an employee whose hourly rate is $0.60 and who spends 192 hrs. in the gang during the month. His day-work value for this time is $0.60 times 192 hr., or $115.20, and his share of the piece-work balance is 35 per cent of this, or $40.32. His total earnings

for the month are the $115.20 of day-work value, plus his $40.32 share of the balance, which amounts to $155.52 in all.

Obviously, to receive the total piece-work earnings in a single payment each month would be rather unsatisfactory from the standpoint of the factory personnel. In order to provide a regular weekly income, therefore, the day-work wage was formerly paid weekly for the first three weeks of the month, and on the fourth week, the day-work wage for that week plus the accrued piece-work balance for the month. This method would pay the operator whom we used in the previous example $28.80 a week for three weeks and $69.12 on the fourth. This method did not provide a sufficiently uniform wage to be entirely satisfactory; therefore we now predict the earnings of each gang based on previous average performances, and pay the predicted balance weekly after deducting a small amount as a safety factor. The same operator now will receive something like $38.00 each week and the remaining $41.52 at the end of the month.

This scheme of paying on a weekly increment at nearly the full percentage each week is made possible largely by the fact that a large number of the steady-running jobs are scheduled so far in advance that a comparatively even flow of work is maintained. The miscellaneous small lot schedules constitute, as a rule, only a small portion of the job.

The only difference between the weekly, bi-weekly, and monthly gang piece-work plans is the final accounting, to determine the overall balance earned by the gang at the end of each payment period.

Only a small percentage of our shop work is handled on a day-work basis. On the few small day-work jobs, which are performed by a group whose normal output consists of a majority of piece-work jobs, the time spent on day-work is charged into the gang just as if the job were piece-work, and the gang is credited with the day-work value of the job. This time of course yields no piece-work balance, and this naturally lowers the piece-work balance for the period in which the time was charged. However, the increasing use of time standards makes it possible to establish piece-rates at a considerably lower cost, resulting in an increased application of piece-work to small lot jobs and a continuous downward trend of the percentage of work performed on a day-work basis.

High working efficiency is attained under this class of wage payment by the fact that many of the associated non-productive functions are included in the gang, which produces highly cooper-

ative effort between the productive and non-productive employees. Due to the personal monetary interest of every member in the performance of the entire group, it has been found that the amount of supervision required is reduced to a minimum. New employees are given a helping hand by other members of the group, while the slacker is quickly informed that he is expected to do his share of the work. Difficulties of this type are usually taken care of within the group to the satisfaction of all concerned.

The gang supervisors maintain records showing the performance of each member of their groups, which gives them an opportunity to locate and assist the members who repeatedly fall below the normal performance of the gang. New ideas are often introduced by operators in the way of improving the efficiency of the operation, and are invariably passed along to the other members of their groups to aid in increasing the over-all output.

Under the gang plan, no inspection is made by the regular inspection organization until the work leaves the gang, and credit is allowed for the performance of good work only. This results in expeditious handling and a smoother flow of work, in order to deliver the work to final inspection with the least amount of delay. The operators in the gang are trained to guard the quality of the work and prevent defective work, since time spent on defective work is lost time, and a penalty to the gang. Since the inspection and crediting operations are performed but once, the cost of these functions is reduced to a minimum.

The feature of prorating the piece-work balance to the members of a gang in accordance with their day-rates places the distinction that should be made between the skill and ability of the different men entirely upon the relative values of their day-rates, since each member receives the same percentage of his day-work value. We feel that this plan is fair to all concerned because of the careful attention that is given to the grading of labor and to the fact that rate revisions are made at regular intervals, at which time each employee is considered from the standpoint of the individual showing made.

We have found that the gang piece-work plan is economical to operate. It is only necessary to maintain records of the day-work time charged to the gang by each operator and to issue work tickets on the entire job. Production control is simplified due to the fact that it is to the interest of each operator to move the product

through the gang as rapidly as possible in order to receive credit for the work performed within a specified time. Payroll expense is minimized, due to the simple and uniform methods used. The operator's total wage is simply his day-work value plus his prorated share of the surplus over the total gang day-work value. Fewer piece-rates are required to handle the crediting of work, due to the use of job or gang piece-rates rather than individual operation rates.

Uniform earnings result from the use of gang piece-work, as any slight variation due to high or low piece-rates is leveled out. This plan also eliminates disputes over the apportionment of work, which may occur in the case of individual piece-work.

This type of piece-work creates a friendly interest between the participants in the gang and between the gang and the management, and therefore reduces discord and dissatisfaction. This community spirit is extended to new employees, who are encouraged and assisted to put forth their best efforts in learning the job.

The gang plan and the method of payment are readily understood by the operator, since all participants receive the same piece-work balance.

Gang piece-work discourages labor turnover and absences, due to the group spirit and to the fact that the maintenance of a steady, highly trained personnel insures maximum gang earnings.

Opposed to these advantages are two arguments which are usually given as disadvantages of group incentives. These are: First, lowered individual efficiency, and second, less individual opportunity.

It is undoubtedly true that the gang type of piece-work has the tendency to lower slightly the efficiency of a few outstanding operators, but it should also be kept in mind that under gang piece-work, this disadvantage is partially balanced by the fact that the below average operator is more quickly trained up to average performance and that highly efficient methods devised by the operators are put in practice by the entire gang more quickly than under any other type of piece-work. While each operator is placed on his own initiative and receives the full benefit of his personal effort under the individual piece-work plan, this type of piece-work will not function successfully under all conditions, and it is in those cases where individual effort is not easily segregated that gang piece-work is most successful.

We partly circumvent the argument that individual opportunity is lacking under gang piece-work by the maintenance of individual efficiency records. These records are used at the periodical rate revision periods and in the selection of candidates for increases and promotion to supervisory positions.

I do not wish to convey the idea that we consider our group incentive plans to be superior to individual piece-work. On the contrary, we feel that individual piece-work is the highest type of incentive, and we apply it to all classes of work where we find it practical to do so. However, since the satisfactory application of individual piece-work is limited to definite manufacturing conditions, we are compelled in other types of work to resort to the group method of wage payment. However, the gratifying results obtained from the application of the group plan leads us to believe that, in general, the decrease in efficiency incurred by the loss of the direct individual incentive is offset at least to some extent by the cooperation, enthusiasm, and community spirit developed by gang piece-work, and by the decreased clerical, payroll, and inspection costs resulting from the use of the gang piece-work plan.

AN INCENTIVE PLAN THAT MADE SUBSTANTIAL REDUCTIONS IN MATERIALS HANDLING COSTS

By R. E. JANSEN

General Dispatcher, Plant Transportation Department, Westinghouse Electric and Manufacturing Company, East Pittsburgh Works

THE shop express system for delivering small packages between departments at the Westinghouse plant was placed upon an incentive wage plan, based on time studies establishing standard tasks, in the manner already described. The industrial railway service was likewise put under a similar incentive plan. These methods worked so well that the scheme was further extended.

The industrial trucking work presented still another problem in measuring performance. In this case, quantity of material and number of delivery points are the two most important factors.

This type of handling work is controlled through four industrial truck dispatch stations which supply service to all points in the plant. Each station operates from 9 to 12 trucks which are supervised by a dispatcher and a station clerk who spends part of his

FIGURE 1. *The dispatch board gives a visual record of all requests for industrial truck service*

time on a truck and the remainder of his time at the station. Each station is responsible for answering all trucking requests within a certain area. These requests are turned in to the station, usually by phone, where they are recorded on a small dispatch tag. On this dispatch tag are noted the points between which the material is to be transferred and the time when the request was made. The

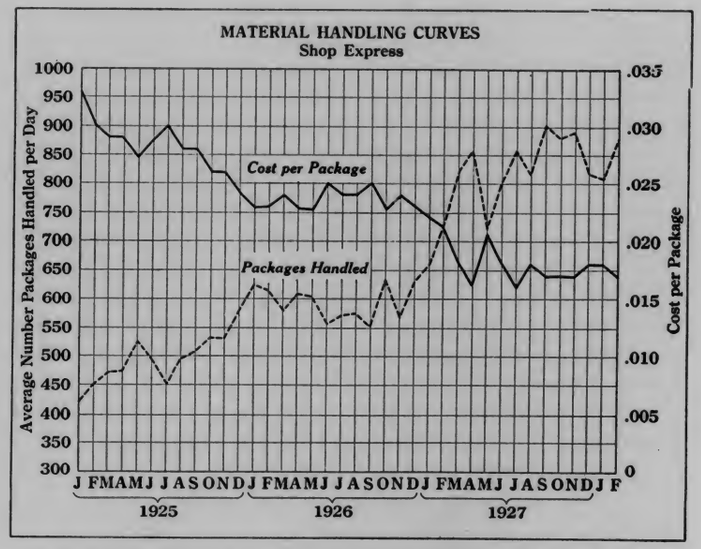


FIGURE 2. *Labor costs for shop express service were considerably reduced during the past three years*

tag is then filed on the board according to the time reported. Later, when a truck is obtained for making the delivery, the truck number is noted and also the time that it takes to make the trip. This plan gives a close check on the operation of each individual trucker. Figure 1 gives some idea of this procedure.

Previous to the establishment of time values, extensive studies were made to determine the amount of time required in transit, loading and unloading material, crane and elevator delays, etc. For those delays which were unnecessary and could be eliminated, no time allowance was made, but a certain amount of time has to be allowed for unavoidable delays. Taking into consideration all the factors which influence the time required for the delivery of material by this method it was decided to make each delivery, up to the maximum of one truck-load, the unit for measuring the work performed.

It would not be fair to make the truck-load a unit of measurement

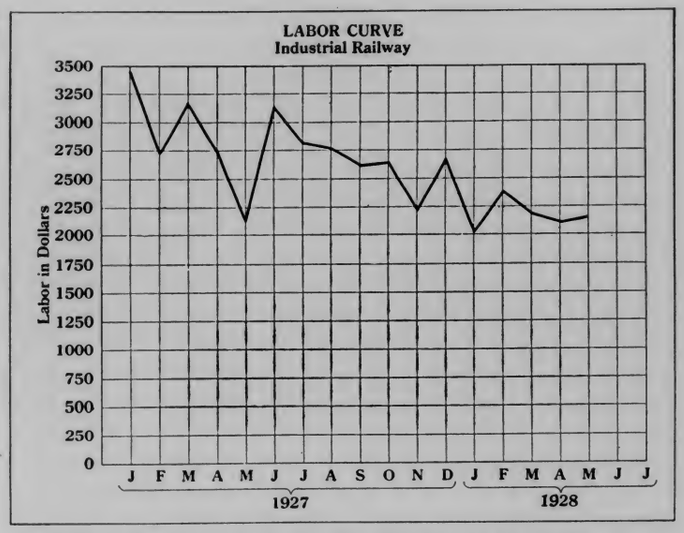


FIGURE 3. *Labor curves for the industrial railway division bear evidence of the effect of wage incentives*

because some loads might be made up of material to be delivered to six or eight different points while others might all go to one point. By delivery of material is meant any amount of material up to a maximum of one truck-load to be delivered to one individual point. Quite naturally it was found that the hoist trucks could make far more trips than the flat trucks, so separate time limits were set for each. On account of the difference in the nature of the work performed by each station it was also found necessary to set a different value at each station, each group of truckers being studied separately.

After detailed studies had been made the following formula was derived for computing the earnings of one of these groups:

$$\text{Time allowed} = [(0.460 \times NF) + (0.317 \times NH) - T.T.]\ .25 + T.T.$$

where

0.460 = Time allowed per delivery for flat truck

0.317 = Time allowed per delivery for hoist truck

NF = Number deliveries made by flat truck
NH = Number deliveries made by hoist truck
TT = Time taken

As in all the other cases, if the group "makes out," the net earnings of the group members amount to their high rate times the standard hours allowed.

Information concerning the number of deliveries of material which each trucker makes comes from the shipping sections in the form of an industrial truck requisition. Each delivery requires one of these requisitions properly signed before the material will be moved. Inasmuch as the dispatcher and station clerk are included in the group it is necessary to vest the authority for issuing these requisitions in someone outside the group. A sample requisition is shown in Figure 6.

The collection of empty tote pans is also done under the standard time incentive. Some 25,000 of these containers are in circulation throughout the plant, and supplying the empty pans furnishes one of the biggest "little" jobs performed by this department. The truckers are given a certain time allowance for the collection of the

FIGURE 4. *Gathering empty tote pans is one of the important functions of the industrial trucks operating on regular routes*

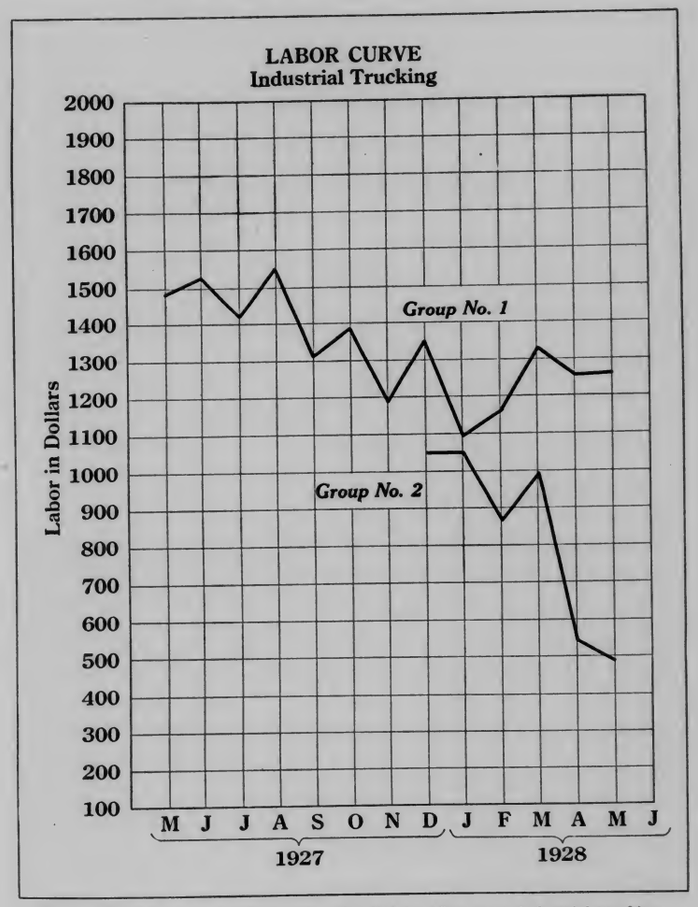


FIGURE 5. *A wage incentive plan has also had its effect upon industrial trucking expense*

pans. Figure 4 shows how these pans are kept in circulation. Some of them are moved to the aisles where they can be very easily obtained, but many times it becomes necessary to hunt for them among

Works Transportation

Form 14284
W. E. & M. Co.
Works Dept.

REQUISITION FOR INDUSTRIAL TRUCK SERVICE

From.....To.....Truck No.....

Material

Signed.....Date.....
Foreman

Printed in U.S.A.

FIGURE 6. *No material is moved by industrial trucks without a requisition*

the machines and in other more remote corners. The result of this collection usually amounts to around 400 per day.

Placing industrial trucking under such incentives brought immediate results. The truckers and dispatcher now coordinate their efforts in every way possible in order to increase their capacity for doing work which, of course, is directly reflected in their pay envelopes. Instead of reporting back to the station after each trip, the truckers call the dispatcher by phone for new trips. Due to credit being given for deliveries instead of loads, they are keeping the trucks more fully loaded and through their own efforts reducing the time lost in delays. In fact, every man in each group is doing his best to hold up his end of the work, for they realize that by properly uniting their efforts they can do more as a group than they can as individuals. In case a man consistently "falls down" in performance he is considered unqualified for the job and transferred to other work.

In the final analysis, management of course must look to the economy of a plan for any justification of its operation. In this case the management has had little reason to hesitate in endorsing the incentive wage payment plans already described. The savings effected can very easily be measured, inasmuch as they are for the most part directly reflected in the payroll.

Not all of the groups have been organized long enough to give a true story of the reductions made. However, a few can be mentioned which offer typical examples of the effects of the wage incentive.

In the handling of the parcel deliveries no reduction has been made in payroll, due to the fact that the work has been more than doubled since the group was first organized. However, as shown by the curves in Figure 2, the plan has caused quite a noticeable reduction in the cost per package. Although these truckers are handling considerably more work than originally set as the "make out" point, they seem to be capable of handling still more work. This has eliminated the necessity of adding more men to take care of such an increase.

TABLE 1—SAVINGS IN LABOR AND DOLLARS

Type of Work	Number Men Employed		Monthly Savings in Dollars	Per Cent Savings	Change in Amount of Work
	Before	Now			
Industrial Railway...	23	16	$893	28	0
Industrial Trucking:					
Group No. 1.....	14	11	122	8.8	12%
Group No. 2.....	8	3	490	50.5	0
Group No. 3.....	10	8	120	10.8	15%
Group No. 4.....	3	3	70	25	106%
Total.....	58	41	$1555	.....	14%

The curve in Figure 3 shows the trend of labor costs of the industrial railway. The first groups were placed in operation in March, 1927, and by the following August they were all working under the wage incentive plan. During this period a reduction of approximately 28 per cent has been made in labor and the car movement has remained about 550 shifts per day. This curve is based upon actual payroll and not upon reduction in number of men employed.

On industrial trucking only two groups have been organized long enough to give reliable data concerning their operation. This data is shown by the curves in Figure 5.

Group No. 1 does not show a very great reduction in payroll, chiefly due to an increase of approximately 12 per cent in the

amount of work. This group was organized on January 1, 1928. Due to the fact that two men were taken out of the group at this time, an immediate drop appears in the curve. For the first two pay periods (one month) they failed to "make out," but as soon as their time allowance was reached the curve went up again. The unusually high figure for March is due largely to the number of working hours in the month. In spite of the increase in work, however, a 9 per cent reduction has been made in labor. In making these monthly comparisons the number of working hours has been taken into consideration, whereas the curves do not show this.

The curve for Group No. 2 is perhaps more striking than any of the others. This group is engaged in the work of collecting refuse at night. Owing to the fact that no separate record was kept of this expense prior to December 1, it is impossible to give more data concerning past performance. This group was organized on April 1 and during this month five out of the eight men formerly employed were transferred to other jobs. The application of the hoist truck to some of this work is partly responsible for this reduction, but most of it is due to the incentive plan. The same amount of work is now being performed at a reduction in labor expense of slightly over 50 per cent.

Other reductions similar to the ones already mentioned have been made in groups recently organized. In the aggregate, the total reduction made through the operation of incentive payment plans has been quite noticeable. Just how much this has been may be more clearly seen by the summary in Table 1.

With the present number of 41 men now employed this total saving of $1,555 per month, although not such a large figure in itself, represents a good-sized percentage of the whole.

Such methods have not only proved economical but have reduced the amount of supervision necessary, systematized the work and increased the workman's rate.

Although it was anticipated that more material would be damaged in transit, the trend has been quite the opposite. With the additional incentive attendance has been bettered.

In fact there seems to be no substantial argument against the incentive wage system as applied to material handling operations in the Westinghouse plant.

LOWERING COSTS BY JOB STANDARDIZATION

By H. B. BAUMBACH
Assistant to Manager, Middletown Car Company

IT IS just as wasteful to duplicate or repeat a job calculation as it is to perform any work in the shop in an unstandardized manner. But, on the other hand, it is a laborious task to tabulate the data for jobs in any sort of usable form to make it available for future operations.

Yet there are elements of data which, if on file in a form easily located and readily applied, not only eliminate endless repetition of calculations but also give greater control over production and stabilize wage rates to the satisfaction of both employer and employee. In other words such a codification and classification release human energy for the task of getting work through the shop in the most expeditious manner and on regular schedule, because both management and men know in advance how long it should take to perform the work and what the labor cost will be.

The present discussion deals with the results of time study and job analysis carried on over a period of 17 years under regular manufacturing conditions. During this time something over a million individual items of data were collected and recorded, dealing with the time and cost involved in fabricating steel and lumber in the manufacture of industrial and transportation equipment.

To be of repeated use it was necessary that the records cover fundamental detailed operations. Accurate values were required to make the resulting compilations and calculations reliable for future work. Where this future work was identical in nature with that on which the records were built, the figures were directly usable. Where it was different from the previous jobs, a ready readjustment of the figures to new bases was necessary.

In the Middletown Car Company, where the data are and have been in regular use, the degree of accuracy existing in the records and the closeness with which calculations can be made have been most remarkable.

While the data collected and herewith presented deal particularly with the processing of steel and lumber in the manufacture of freight, industrial, dump and mine cars, the figures are not limited in their application to this one field. They apply equally well in

other industries where steel and wood are handled and fabricated. Moreover, it is believed the methods employed will enable a manufacturer in any other industry to undertake similar studies in his own plant and bring about equivalent savings. With the idea that they will be thus quite universally serviceable, the data and methods are herewith presented.

The way in which the time studies were conducted and the form in which the results have been compiled in charts not only provides a basis for job standardization, but also puts the figures in balance one with the other. In a large portion of the compilation, handling of work to and from machines is used as a basis. The actual work done on the machine is performed between such handlings and resolves itself into a mathematical factor.

The first requisite for the system is a sound time and motion study formula. The formula on which all of our calculations are based is shown herewith. Piece-work figures are used in the calculations. Experience in our case has shown piece-work wage payment to be superior to all other methods, both from a shop and an accounting standpoint, and particularly on the class of work here represented. However, a piece-work system must adhere to accuracy and fairness to be effective. If the different kinds of work are not balanced equitably against each other from the wage payment standpoint, the system will not function with the fullest satisfaction.

The time and motion study formula which we use is very simply expressed, and consists of two separate equations:

$$A \times \frac{B}{C} \times \begin{cases} F \\ N \\ S \end{cases} \times \begin{cases} H \\ M \\ L \end{cases} = D \qquad (1)$$

$$\frac{E}{D} = G \text{ or } \frac{E}{G} = D \qquad (2)$$

where

A = Number of pieces timed
B = Minutes in one hour (60)
C = Time consumed, min.
D = Production per hr.
E = Earnings per hr.
G = Piece-work price per 100 pieces

Working Speed

F = Fast 80%
N = Normal 90%
S = Slow 100%

Working Load

H = Heavy 90%
M = Medium 95%
L = Light 100%

In making the calculations each operation is taken as a complete cycle repeated regularly.

As a working illustration of the formula and its application we will take the performance of one man working on a bar shear and shearing bars 2 in. x ¼ in. x 10 ft. 0 in. long into pieces 2 in. x ¼ in. x 12 in. long.

Operation	*Time Min.*
The man takes the bar from the pile located close to the shear and places it in the machine	0.14
Operates the machine and shears to gage 10 pieces 12 in. long	0.57
Removes sheared pieces from machine and places them in a receptacle for crane or other handling equipment to take away	0.22
Total time for the operation	0.93

The above time is taken with a decimal stop watch and calculated in decimals of a minute for finished pieces.

The calculations by formula are as follows:

A = Number of pieces timed 10
B = Min. in one hr. 60
C = Time consumed, min. 0.93
F = Working speed (fast) 80%
L = Working load (light) 100%

$$10 \times \frac{60}{0.93} \times 0.80 \times 1.00 = 516 \text{ pieces, production per hr.}$$

The earnings are based on a $0.67 per hr. rate.

$$\frac{0.67}{516} = \$0.13 \text{ per 100 pieces.}$$

We will now check the above figures by the use of the corresponding wage table and chart. Referring to Table 1, we note that for shearing 2 in. x ¼ in. bars up to 100 in. long the wage rate ranges from $0.09 to $0.50 per 100 pieces. On Chart 1, using a ruler or straight-edge, preferably one made from celluloid or other transparent material, place one end with its edge at the intersection of horizontal line 1 in. and vertical line $0.09, and move the ruler until the other end of this same edge touches the intersection of horizontal line 100 in. and vertical line $0.50. Now, by noting where horizontal line 12 in., the length of the pieces cut in the problem, intersects the straight-edge, and following down the corresponding vertical, we find that this vertical reading is $0.13, which is the correct

TABLE 1

SHEARING BARS 1 INCH TO 100 INCHES LONG

Inches	Dollars
¼ Rd.	.04 to .35
⅜ Rd. 1 x ⅛	.05 to .40
½ Rd. 1½ x ⅛	.06 to .43
⅝ Rd. 2 x ⅛ 1 x ¼	.07 to .45
¾ Rd. 3 x ⅛ 1½ x ¼ 1 x ⅜	.08 to .48
⅞ Rd. 4 x ⅛ 2 x ¼ 1 x ½ 1½ x ⅜	.09 to .50
1 Round 5 x ⅛ 2½ x ¼ 1 x ⅝	.10 to .52
1⅛ Rd. 6 x ⅛ 3 x ¼ 2 x ⅜ 1½ x ½ 1 x ¾	.11 to .54
1¼ Rd. 3½ x ¼ 2½ x ⅜ 2 x ½ 1½ x ⅝	.12 to .56
1⅜ Rd. 4 x ¼ 3 x ⅜ 2½ x ½ 2 x ⅝ 1½ x ¾ 1 x ⅞	.13 to .58
1½ Rd. 4½ x ¼ 3½ x ⅜ 3 x ½ 2½ x ⅝ 2 x ¾ 1½ x ⅞ 1 x 1	.14 to .60
1⅝ Rd. 5 x ¼ 4 x ⅜ 3½ x ½ 3 x ⅝ 2½ x ¾ 2 x ⅞ 1½ x 1	.15 to .63
1¾ Rd. 5½ x ¼ 4½ x ⅜ 4 x ½ 3½ x ⅝ 3 x ¾ 2½ x ⅞ 2 x 1 1½ x 1⅛	.16 to .66
1⅞ Rd. 6 x ¼ 5 x ⅜ 4½ x ½ 4 x ⅝ 3½ x ¾ 3 x ⅞ 2½ x 1 2 x 1⅛ 1½ x 1¼	.17 to .69
2 Round 5½ x ⅜ 5 x ½ 4½ x ⅝ 4 x ¾ 3½ x ⅞ 3 x 1 2½ x 1⅛ 2 x 1¼	.18 to .72
2⅛ Rd. 6 x ⅜ 5½ x ½ 5 x ⅝ 4½ x ¾ 4 x ⅞ 3½ x 1 3 x 1⅛ 2½ x 1¼ 2 x 1⅜	.19 to .75
2¼ Rd. 6 x ½ 5½ x ⅝ 5 x ¾ 4½ x ⅞ 4 x 1 3½ x 1⅛ 3 x 1¼ 2½ x 1⅜ 2 x 1½	.20 to .77
2⅜ Rd. 6 x ⅝ 5½ x ¾ 5 x ⅞ 4½ x 1 4 x 1⅛ 3½ x 1¼ 3 x 1⅜ 2½ x 1½	.21 to .80
2½ Rd. 6 x ¾ 5½ x ⅞ 5 x 1 4½ x 1⅛ 4 x 1¼ 3½ x 1⅜ 3 x 1½	.22 to .82
2⅝ Rd. 6 x ⅞ 5½ x 1 5 x 1⅛ 4½ x 1¼ 4 x 1⅜ 3½ x 1½	.23 to .85
2¾ Rd. 6 x 1 5½ x 1⅛ 5 x 1¼ 4½ x 1⅜ 4 x 1½	.24 to .88
2⅞ Rd. 6 x 1⅛ 5½ x 1¼ 5 x 1⅜ 4½ x 1½	.26 to .92
3 Round 6 x 1¼ 5½ x 1⅜ 5 x 1½	.28 to .95
3⅛ Rd. 6 x 1⅜ 5½ x 1½	.30 to .98

NOTE: Starting prices for bars based on bars 1 in. long.

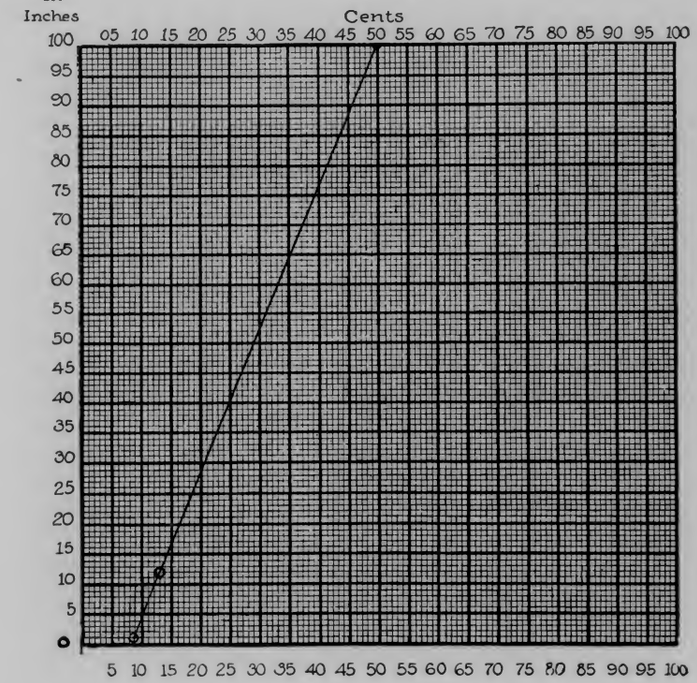
rate per 100 pieces. All fabricating prices figured from the chart are on the basis of 100 pieces.

When the piece work price is obtained the production standard is calculated by the equation

$$D = \frac{E}{G} = \frac{\$0.67}{\$0.13} = 516 \text{ pieces per hr.}$$

The question arises: Are these rate and production standards fair? With the working speed fast and the working load light the calculated standard working time of this man is $60 \times 0.80 \times 1.00 = 48$ min. per hr. The remaining 12 min. of the hour allows for relaxation and rest. The man is to work at this gait 6.4 hr. out of an 8-hr. day to earn $0.67 per hr. or $5.36 per day.

CHART I



The accompanying tables give, for bars of different dimensions, from the smallest to the largest that we process, the respective wage rates per 100 pieces cut. Three ranges of length are used as the basis of the calculations: Bars up to 100 in. (8 ft. 4 in.) long; bars from 8 ft. 4 in. to 25 ft. long; and bars from 25 ft. to 41 ft. 8 in. long.

Three charts corresponding to the three ranges of length have been prepared for use in making these cost calculations.

For any size bar, set the straight-edge on the cross section paper as follows: Place the lower edge at the intersection of the horizontal for the minimum length specified in any table and the vertical for the lowest price indicated for the size of bar in question. Set the upper edge of the straight-edge to coincide with the intersection of the 100-in. (or 25 ft., or 41 ft. 8 in.) horizontal line at the top

TABLE 2

SHEARING BARS 8 FEET 4 INCHES TO 25 FEET LONG

Inches	Dollars	Inches	Dollars	Inches	Dollars
¼ Rd.	.35 to .70	1¼ Rd. 3½ x ¼ 2½ x ⅜ 2 x ½ 1½ x ⅝	.56 to 1.15	1¾ Rd. 5½ x ¼ 4½ x ⅜ 4 x ½ 3½ x ⅝	.66 to 1.35
⅜ Rd. 1 x ⅛	.40 to .80	1⅜ Rd. 4 x ¼ 3 x ⅜ 1½ x ½ 2 x ⅝ 1¼ x ¾ 1 x ⅞	.58 to 1.20	3 x ¾ 2½ x ⅞ 2 x 1 1½ x ⅛	
½ Rd. 1½ x ⅛	.43 to .85	1½ Rd. 4½ x ¼ 3½ x ⅜ 3 x ½ 2½ x ⅝ 2 x ¾ 1½ x ⅞	.60 to 1.25	1⅞ Rd. 6 x ¼ 5 x ⅜ 4½ x ½ 4 x ⅝ 3½ x ¾ 3 x ⅞ 2½ x 1 2 x 1⅛ 1½ x 1¼	.69 to 1.40
⅝ Rd. 2 x ⅛ 1 x ¼	.45 to .90	1⅝ Rd. 5 x ¼ 4 x ⅜ 3½ x ½ 3 x ⅝ 2½ x ¾ 2 x ⅞ 1½ x 1	.63 to 1.30	2 Round 5½ x ⅜ 5 x ½ 4½ x ⅝ 4 x ¾ 3½ x ⅞ 3 x 1 2½ x 1⅛ 2 x 1¼	.72 to 1.45
¾ Rd. 3 x ⅛ 1½ x ¼ 1 x ⅜	.48 to .95				
⅞ Rd. 4 x ⅛ 2 x ¼ 1½ x ⅜ 1 x ½	.50 to 1.00				
Divide[1] and multiply by 1					
1 Round 5 x ⅛ 2½ x ¼ 1 x ⅝	.52 to 1.05				
1⅛ Rd. 6 x ⅛ 3 x ¼ 2 x ⅜ 1½ x ½ 1 x ¾	.54 to 1.10				
Divide[1] and multiply by 2		Divide[1] and multiply by 2		Divide[1] and multiply by 2	

of the chart and the vertical for the maximum price listed for the size of bar in question. Read across the horizontal line of the length into which the bars are to be cut, until the straight-edge is reached, and then down to the corresponding vertical. This latter reading is the correct price per 100 pieces, on a wage rate with $0.67 per hr. as a basis. For other wage rates a conversion factor must be used as a direct multiplier. That is, for a rate of $0.75 per hr. as a basis, the multiplier would be the ratio $0.75/$0.67.

For intermediate sizes, use averages between the next higher and the next lower sizes. In some cases this calculation may have to be on a proportional basis, for the size in question may not be just half-way between two of the sizes listed.

In the fabricating of sheet steel the calculation of wage rates is complicated by the many different thicknesses of sheets and plates

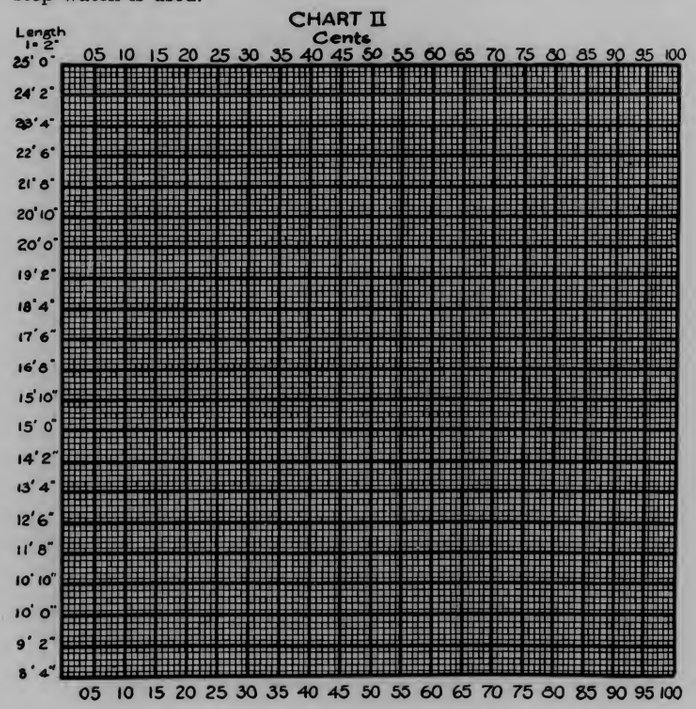
TABLE 2 (continued)

SHEARING BARS 8 FEET 4 INCHES TO 25 FEET LONG

Inches	Dollars	Inches	Dollars	Inches	Dollars
2⅛ Rd. 6 x ⅜ 5½ x ½ 5 x ⅝ 4½ x ¾ 4 x ⅞ 3½ x 1 3 x 1⅛ 2½ x 1¼ 2 x 1⅜	.75 to 1.50	2⅜ Rd. 6 x ⅝ 5½ x ¾ 5 x ⅞ 4½ x 1 4 x 1⅛ 3½ x 1¼ 3 x 1⅜ 2½ x 1½	.80 to 1.60	2¾ Rd. 6 x 1 5½ x 1⅛ 5 x 1¼ 4½ x 1⅜ 4 x 1½	.88 to 1.75
2¼ Rd. 6 x ½ 5½ x ⅝ 5 x ¾ 4½ x ⅞ 4 x 1 3½ x 1⅛ 3 x 1¼ 2½ x 1⅜ 2 x 1½	.77 to 1.55	2½ Rd. 6 x ¾ 5½ x ⅞ 5 x 1 4½ x 1⅛ 4 x 1¼ 3½ x 1⅜ 3 x 1½	.82 to 1.65	2⅞ Rd. 6 x 1⅛ 5½ x 1¼ 5 x 1⅜ 4½ x 1½	.92 to 1.80
Divide[1] and multiply by 2		2⅝ Rd. 6 x ⅞ 5½ x 1 5 x 1⅛ 4½ x 1¼ 4 x 1⅜ 3½ x 1½	.85 to 1.70	3 Round 6 x 1¼ 5½ x 1⅜ 5 x 1½	.95 to 1.85
[1]The reason for the dividing and multiplying factor is to bring the prices within the scale of the chart.		Divide[1] and multiply by 2		3⅛ Rd. 6 x 1⅜ 5½ x 1½	.98 to 1.90
				3¼ Rd. 6 x 1½	1.00 to 1.95
				Divide[1] and multiply by 2	
				NOTE: Starting prices based on bars 8′4″ long	

which are sheared and by the innumerable lengths into which these sheets may be cut. The cost of time study on each individual size and length is prohibitive. It is possible, however, on the basis of time studies made on certain thicknesses and sizes of sheets to develop methods whereby adequate wage rates for a wide range of intermediate sizes can be calculated with fairness to both employer and employee. This plan has been developed and applied at the Middletown Car Company and is operating with uniform success. The basis upon which the rates have been set and charts and tables for graphically determining these rates are here presented.

To illustrate the method we will take the performance of two men working on a plate shear, shearing plates 16 in. x ¼ in. x 8 ft. 4 in. long into pieces 16 in. x ¼ in. x 1 ft. 8 in. long. The decimal stop watch is used.



Operation

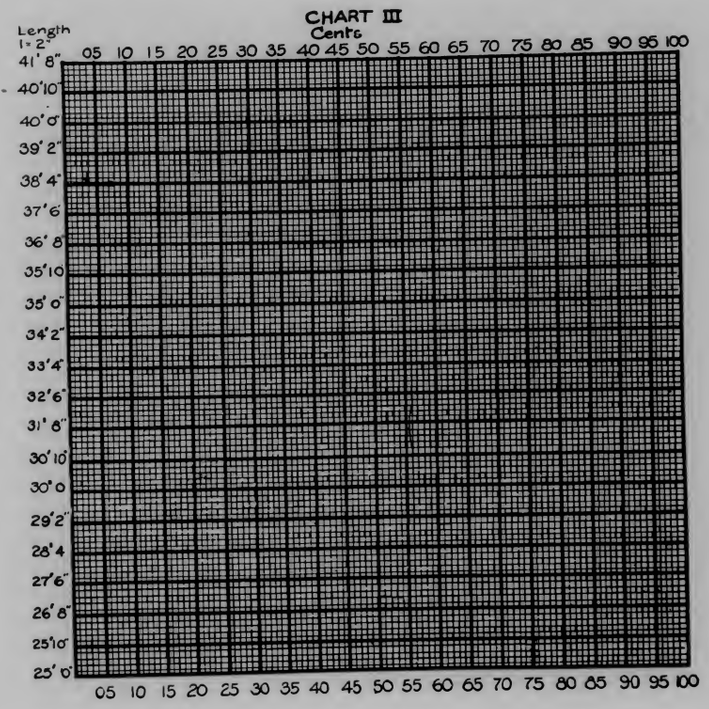
One man takes the plate from the pile located close to the shear (the pile is higher than the bed or table of the machine so there is no lifting) and places it in the machine, time, min. . 0.22

Operates the machine and shears to gage 5 pieces 1 ft. 8 in. long 0.357

Total time for the operation 0.577

The second man assists to gage and removes finished pieces from the machine and piles them in a receptacle, ready for the crane or other handling equipment to remove 0.577

The entire operation has therefore taken 0.577 two-man-min.



In accordance with the formula the calculations are:

A = Number of pieces timed 5
B = Min. in one hour 60
C = Time consumed, min 0.577
N = Working speed (normal) 90%
M = Working load (medium) 95%

$$5 \times \frac{60}{0.577} \times 0.90 \times 0.95 = 445 \text{ pieces, production per hr.}$$

The earnings are based on a $0.67 per hr. rate for one man, or $1.34 per hr. for two men.

$$\frac{\$1.34}{445} = \$0.30 \text{ per 100 pieces 16 in. x } \tfrac{1}{4} \text{ in. x 1 ft. 8 in. long.}$$

TABLE 3

SHEARING BARS 25 FEET TO 41 FEET 8 INCHES LONG

Inches	Dollars	Inches	Dollars	Inches	Dollars
¼ Rd.	.70 to 1.00	1¼ Rd. 3½ x ¼ 2½ x ⅜ 2 x ½ 1½ x ⅝	1.15 to 1.80	1¾ Rd. 5½ x ¼ 4½ x ⅜ 4 x ½ 3½ x ⅝ 3 x ¾ 2½ x ⅞ 2 x 1 1½ x 1⅛	1.35 to 2.20
⅜ Rd. 1 x ⅛	.80 to 1.15	1⅜ Rd. 4 x ¼ 3 x ⅜ 2½ x ½ 2 x ⅝ 1½ x ¾ 1 x ⅞	1.20 to 1.90	1⅞ Rd. 6 x ¼ 5 x ⅜ 4½ x ½ 4 x ⅝ 3½ x ¾ 3 x ⅞ 2½ x 1 2 x 1⅛ 1½ x 1¼	1.40 to 2.30
½ Rd. 1½ x ⅛	.85 to 1.25	1½ Rd. 4½ x ¼ 3½ x ⅜ 3 x ½ 2½ x ⅝ 2 x ¾ 1½ x ⅞ 1 x 1	1.25 to 2.00	2 Round 5½ x ⅜ 5 x ½ 4½ x ⅝ 4 x ¾ 3½ x ⅞ 3 x 1 2½ x 1⅛ 2 x 1¼	1.45 to 2.40
⅝ Rd. 2 x ⅛ 1 x ¼	.90 to 1.35	Divide[1] and multiply by 2			
¾ Rd. 3 x ⅛ 1½ x ¼ 1 x ⅜	.95 to 1.45	1⅝ Rd. 5 x ¼ 4 x ⅜ 3½ x ½ 3 x ⅝ 2½ x ¾ 2 x ⅞ 1½ x 1	1.30 to 2.10		
⅞ Rd. 4 x ⅛ 2 x ¼ 1½ x ⅜ 1 x ½	1.00 to 1.50				
1 Round 5 x ⅛ 2½ x ¼ 1 x ⅝	1.05 to 1.60				
1⅛ Rd. 6 x ⅛ 3 x ¼ 2 x ⅜ 1½ x ½ 1 x ¾	1.10 to 1.70				
Divide[1] and multiply by 2		Divide[1] and multiply by 4		Divide[1] and multiply by 4	

We will now take up the same problem and apply the wage chart. In Chart IV the ruler or straight-edge is placed with the lower end of one edge at the intersection of horizontal line 16 in. and vertical line $0.27, while the upper end of the same edge is moved until it touches the intersection of horizontal line 100 in. and vertical line $0.90. For ¼ in. plate 16 in. wide the limits of wage rates are $0.27 and $0.90. If we now follow across horizontal line 20 in., the length of the sheared pieces, to its intersection with the straight-edge, and trace the corresponding vertical down to the base line, we find that the rate indicated is $0.30 per 100 pieces, which was obtained from the above calculation.

The production standard per hr. is

$$D = \frac{E}{G} = \frac{\$1.34}{\$0.30} = 445 \text{ pieces per hr.}$$

TABLE 3 (continued)

SHEARING BARS 25 FEET TO 41 FEET 8 INCHES LONG

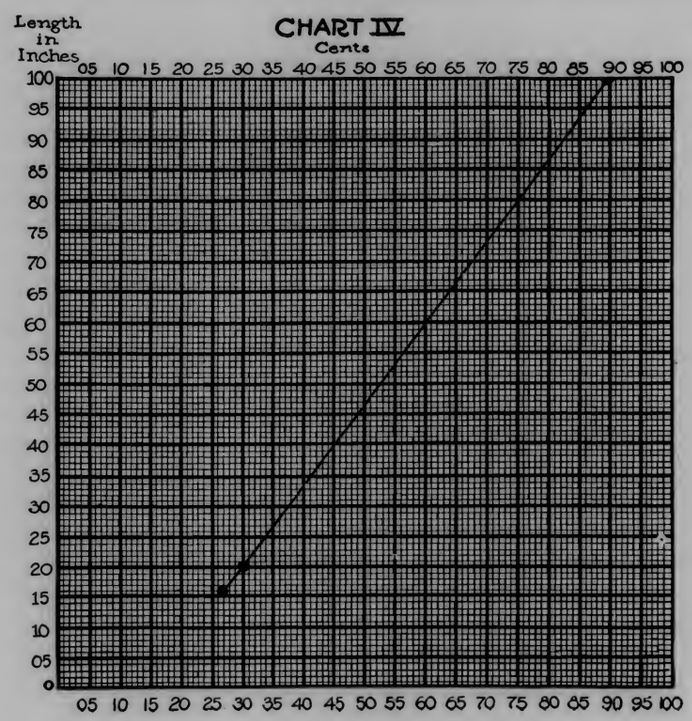
Inches	Dollars	Inches	Dollars	Inches	Dollars
2⅛ Rd. 6 x ⅜ 5½ x ½ 5 x ⅝ 4½ x ¾ 4 x ⅞ 3½ x 1 3 x 1⅛ 2½ x 1¼ 2 x 1⅜	1.50 to 2.50	2⅜ Rd 6 x ⅝ 5½ x ¾ 5 x ⅞ 4½ x 1 4 x 1⅛ 3½ x 1¼ 3 x 1⅜ 2½ x 1½	1.60 to 2.70	2¾ Rd. 6 x 1 5½ x 1⅛ 5 x 1¼ 4½ x 1⅜ 4 x 1½	1.75 to 3.00
2¼ Rd. 6 x ½ 5½ x ⅝ 5 x ¾ 4½ x ⅞ 4 x 1 3½ x 1⅛ 3 x 1¼ 2½ x 1⅜ 2 x 1½	1.55 to 2.60	2½ Rd. 6 x ¾ 5½ x ⅞ 5 x 1 4½ x 1⅛ 4 x 1¼ 3½ x 1⅜ 3 x 1½ 2⅝ Rd. 6 x ⅞ 5½ x 1 5 x 1⅛ 4½ x 1¼ 4 x 1⅜ 3½ x 1½	1.65 to 2.80 1.70 to 2.90	2⅞ Rd. 6 x 1⅛ 5½ x 1¼ 5 x 1⅜ 4½ x 1½ 3 Round 6 x 1¼ 5½ x 1⅜ 5 x 1½ 3⅛ Rd. 6 x 1⅜ 5½ x 1½ 3¼ Rd. 6 x 1½	1.80 to 3.10 1.85 to 3.20 1.90 to 3.30 1.95 to 3.40
Divide[1] and multiply by 4		Divide[1] and multiply by 4		Divide[1] and multiply by 4	

[1]The reason for the dividing and multiplying factor is to bring the prices within the scale of the chart.

NOTE: Starting prices based on bars 25′0″ long

With the working speed normal and the working load medium the working time of these two men is calculated as 60 × \$0.90 × 0.95 = 51.3 min. per hr. each. The remaining 8.7 min. allows for relaxation. The men work at this normal gait 6.8 hr. out of an 8-hr. day to earn \$0.67 per hr. each, or \$5.36 per day. Proper compensation has thus been allowed for the working conditions met with under standard operation.

If it is desired to shear plates 7 in. wide, ¼ in. thick, and 100 in. long, up to 21 in. wide, ¼ in. thick, and 100 in. long, the same chart serves to give the piece-work prices and the hourly production standards. Thousands of different combinations are possible with



this one chart within the widths and inches in length represented. Additional intermediate sizes varying by ½ in. widths from those given on the chart are taken care of by taking averages of the two nearest full inch sizes. Variations of 1/16 in. in thickness are compensated for by averages between the charts for plates ¼ in. thick and ⅜ in. thick.

For other wage rates a conversion factor must be used as a direct multiplier. That is, for a rate of \$0.75 per hr. as a basis, the multiplier would be the ratio \$0.75/\$0.67.

For intermediate sizes, use averages between the next higher and the next lower sizes. In some cases this calculation may have to be on a proportional basis, for the size in question may not be just half-way between two of the sizes listed.

Time study does not always take into account all the factors in a job, and consequently sometimes works injustice to the operator on a machine. As a proof of this statement we will take for illustration the shearing of the 16 in. x ¼ in. x 1 ft. 8 in. plate forming the basis of the time study calculation above, and compare it with the shearing of a 16 in. x 5/16 in. x 1 ft. 8 in. plate. The time study of both would show practically the same results, but in shearing the 16 in. x 5/16 in. x 1 ft. 8 in. plate the men would handle 25 per cent more weight of material per hr. than in shearing the 16 in. x ¼ in. x 1 ft. 8 in. plate.

Using the chart for ¼ in. plate, we get a price of \$0.30 in. per 100 pieces as the wage rate to be paid. Using the chart for ⅜ in. plate and placing the straight-edge at the intersections of horizontal 16 in. wage rate \$0.29 and horizontal 100 in. wage rate \$1.01, we read for the 20 in. length a rate of \$0.32. Averaging the rate for ¼ in. and ⅜ in. plates to arrive at the correct rate for 5/16 in. plate, we get \$0.31 as the price per 100 pieces. Calculation to obtain the correct standard production shows it to be 432 pieces per hr.

The above case shows how the charts eliminate the shortcomings of time study. The element of fatigue which enters into the case used for illustration is not detected in the time study observation unless the readings are taken over a long period, which is usually too costly a plan to adopt. Moreover, by the use of the charts calculations can be made which it is unnecessary to check by time study observations.

The charts illustrated in this series of articles are only a few from a large set built up through a period of several years. The

TABLE 4. SHEARING STEEL PLATES ⅛ TO ¾ INCH THICKNESSES, AND FROM 7 TO 74 INCHES LONG

Length in Inches	Thickness in Inches					
	⅛	¼	⅜	½	⅝	¾
7	$ .12– .56	$ .18– .72	$ .20– .78	$ .22– .82	$ .24– .85	$ .26– .88
8	.13– .58	.19– .74	.21– .80	.23– .84	.25– .87	.27– .90
9	.14– .60	.20– .76	.22– .82	.25– .87	.27– .90	.29– .93
10	.15– .62	.21– .78	.23– .84	.26– .89	.29– .93	.31– .96
11	.16– .64	.22– .80	.24– .86	.28– .92	.31– .96	.33–1.00
12	.17– .66	.23– .82	.25– .89	.29– .94	.33– .99	.35–1.04
13	.18– .68	.24– .84	.26– .92	.31– .97	.35–1.03	.38–1.09
14	.19– .70	.25– .86	.27– .95	.32–1.00	.37–1.07	.40–1.14
15	.20– .72	.26– .88	.28– .98	.34–1.03	.40–1.11	.43–1.18
16	.21– .74	.27– .90	.29–1.01	.36–1.06	.43–1.15	.46–1.23
17	.22– .76	.28– .92	.30–1.04	.38–1.09	.46–1.19	.50–1.28
18	.23– .78	.29– .94	.32–1.07	.40–1.13	.48–1.24	.54–1.33
19	.24– .80	.30– .96	.34–1.10	.42–1.17	.51–1.29	.58–1.38
20	.26– .82	.32– .98	.36–1.13	.45–1.21	.54–1.34	.62–1.44
21	.28– .84	.34–1.00	.38–1.16	.48–1.25	.57–1.39	.66–1.50
22	.30– .86	.36–1.02	.40–1.19	.51–1.29	.60–1.44	.70–1.56
23	.32– .88	.38–1.04	.42–1.22	.54–1.33	.63–1.49	.74–1.62
24	.34– .90	.40–1.06	.44–1.25	.57–1.37	.66–1.54	.78–1.68
25	.36– .92	.42–1.08	.46–1.28	.60–1.41	.69–1.59	.82–1.74
26	.38– .94	.44–1.10	.49–1.31	.63–1.45	.72–1.64	.86–1.80
27	.40– .96	.46–1.12	.52–1.34	.66–1.49	.76–1.69	.90–1.86
28	.42– .98	.48–1.14	.55–1.37	.69–1.53	.80–1.74	.94–1.92
29	.44–1.01	.50–1.16	.58–1.40	.72–1.57	.84–1.82	.98–1.98
30	.46–1.04	.53–1.20	.61–1.44	.75–1.62	.88–1.86	1.03–1.05
31	.48–1.07	.56–1.24	.64–1.48	.78–1.67	.92–1.92	1.08–2.12
32	.50–1.10	.59–1.28	.67–1.52	.81–1.72	.96–1.98	1.13–2.19
33	.52–1.13	.62–1.32	.70–1.56	.84–1.77	1.00–2.04	1.18–2.26
34	.54–1.16	.65–1.36	.73–1.60	.87–1.82	1.04–2.10	1.23–2.33
35	.56–1.19	.68–1.40	.76–1.64	.90–1.87	1.08–2.16	1.28–2.40
36	.58–1.22	.71–1.44	.79–1.68	.93–1.92	1.12–2.22	1.33–2.47
37	.60–1.25	.74–1.48	.82–1.72	.96–1.97	1.16–2.28	1.38–2.54
38	.63–1.28	.77–1.52	.85–1.76	.99–2.02	1.20–2.34	1.43–2.61
39	.66–1.31	.80–1.56	.88–1.80	1.02–2.07	1.24–2.40	1.48–2.68
40	.69–1.34	.84–1.60	.91–1.84	1.05–2.12	1.28–2.46	1.53–2.75
41	.72–1.37	.88–1.64	.95–1.88	1.08–2.17	1.32–2.52	1.58–2.82
42	.75–1.40	.92–1.68	.99–1.92	1.12–2.22	1.36–2.58	1.63–2.89
43	.78–1.43	.96–1.72	1.03–1.96	1.16–2.27	1.40–2.64	1.68–2.96
44	.81–1.46	1.00–1.76	1.07–2.00	1.20–2.32	1.44–2.70	1.73–2.03
45	.84–1.49	1.04–1.80	1.11–2.05	1.25–2.38	1.48–2.76	1.78–3.10
46	.87–1.52	1.08–1.84	1.16–2.10	1.30–2.44	1.53–2.82	1.83–3.17
47	.90–1.55	1.12–1.88	1.20–2.15	1.35–2.50	1.58–2.88	1.88–3.24
48	.93–1.58	1.16–1.92	1.25–2.20	1.40–2.56	1.63–2.94	1.94–3.31
49	.96–1.61	1.20–1.96	1.30–2.25	1.45–2.62	1.68–3.00	2.00–3.38
50	.99–1.64	1.24–2.00	1.35–2.30	1.50–2.68	1.73–3.06	2.06–3.46
51	1.02–1.67	1.28–2.04	1.40–2.35	1.55–2.74	1.78–3.12	2.12–3.54
52	1.05–1.70	1.32–2.08	1.45–2.40	1.60–2.80	1.83–3.18	2.18–3.62
53	1.08–1.73	1.36–2.12	1.50–2.45	1.65–2.86	1.88–3.24	2.24–3.70
54	1.11–1.76	1.40–2.16	1.55–2.50	1.70–2.92	1.93–3.30	2.30–3.78
55	1.14–1.79	1.44–2.20	1.60–2.55	1.75–2.98	1.98–3.37	2.36–3.86
56	1.17–1.82	1.48–2.24	1.65–2.60	1.80–3.04	2.04–3.44	2.43–3.94
57	1.20–1.85	1.52–2.28	1.70–2.65	1.86–3.10	2.10–3.51	2.50–4.02
58	1.23–1.88	1.56–2.32	1.75–2.70	1.92–3.16	2.16–3.58	2.57–4.10
59	1.26–1.91	1.60–2.36	1.80–2.75	1.98–3.22	2.22–3.65	2.64–4.18
60	1.30–1.95	1.65–2.40	1.85–2.80	2.04–3.28	2.28–3.72	2.71–4.26
61	1.34–1.99	1.70–2.45	1.90–2.85	2.10–3.34	2.34–3.79	2.78–4.34
62	1.38–2.03	1.75–2.50	1.95–2.90	2.16–3.40	2.41–3.87	2.85–4.42
63	1.42–2.07	1.80–2.55	2.00–2.95	2.22–3.46	2.48–3.94	2.92–4.50
64	1.46–2.11	1.85–2.60	2.05–3.00	2.28–3.52	2.55–4.01	2.99–4.58
65	1.50–2.15	1.90–2.65	2.10–3.05	2.34–3.58	2.62–4.08	3.06–4.66
66	1.54–2.19	1.95–2.70	2.15–3.10	2.40–3.64	2.69–4.15	3.13–4.72
67	1.58–2.23	2.00–2.75	2.20–3.15	2.46–3.70	2.76–4.22	3.20–4.80
68	1.62–2.28	2.05–2.80	2.25–3.20	2.52–3.76	2.83–4.29	3.27–4.88
69	1.66–2.33	2.10–2.85	2.30–3.25	2.58–3.82	2.90–4.36	3.34–4.96
70	1.70–2.38	2.15–2.90	2.35–3.30	2.64–3.88	2.95–4.43	3.41–5.04
71	1.74–2.43	2.20–2.95	2.40–3.35	2.70–3.94	3.04–4.50	3.48–5.12
72	1.78–2.48	2.25–3.00	2.45–3.40	2.76–4.00	3.11–4.57	3.55–5.20
73	1.82–2.53	2.30–3.05	2.50–3.45	2.82–4.06	3.18–4.64	3.62–5.28
74	1.86–2.58	2.35–3.10	2.55–3.50	2.88–4.12	3.25–4.71	3.70–5.36

NOTE: Above first horizontal line in each column the figures can be used directly on the charts. Since the remaining figures extend beyond the limits of the chart cross-section sheets, it is necessary first to divide them by a factor in order to bring them within these limits, and then to multiply them by the same factor to find the actual rates.

Thus, between the first and second horizontal lines in each column divide and multiply by 2; between the second and third horizontal lines divide and multiply by 4. In column 4 for ½ in. sheets the last two values are to be divided and multiplied by 5. In columns 5 and 6 for ⅝ and ¾ in. sheets, respectively, the values below the last horizontal line are to be divided and multiplied by 6.

basis of the work was, of course, time and motion study. The data collected were carefully classified and recorded. Actual shop performances over a considerable period were investigated to see where practical operating conditions modified the ideal results obtained from time study observations. That is, the average allowances for personal needs, fatigue, delays, machine troubles and similar elements that increase the time on jobs and lower the theoretical production, were not based on assumed percentages but were introduced from the results of actual experiences under normal operating conditions.

Using the figures calculated from the time study formula, together with actual shop performances and prevailing wage rates that were mutually satisfactory to management and men, the charts were built up.

The differences in time and effort required to perform operations that were similar to those for which standards had been set—such as trimming or notching in place of shearing—were ascertained and their value in labor rates expressed by modifying factors entered on the charts.

HOW GROUP BONUS AIDS THE SUPERINTENDENT

By D. B. KIFT

General Superintendent, Edison Electric Appliance Company

When contemplating the installation of a wage payment incentive plan, the first thought is necessarily given to cost reduction in the form of more production per man-hour. This, if accomplished, not only lowers direct labor cost but lets one come nearer to obtaining maximum production per machine-hour, which is also much to be desired. Such reduction, of course, can be accomplished to a certain extent by almost any incentive plan, whether piece-work, gang piece-work, or any of the numerous so-called group bonus plans.

To my mind, however, a plan to be really effective must not only affect direct labor, as noted above, but must control indirect labor as well. To obtain the best effort from everyone concerned it must provide an incentive for supervision that is worth while, so that supervisors, foremen, assistants, etc., will feel the same keen interest in their work that they would if the business were their own.

Such a plan is the group bonus plan in successful operation in the Edison Electric Appliance Company factories for a number of years. Out of my experience with this I would like to bring out a point that is often overlooked when installing wage incentive plans, and that is the aid our bonus plan has given me, the superintendent. To my mind, such a positive incentive lets me obtain the best possible results through the foremen and their assistants. The tactics of the old fashioned superintendent, who depended almost entirely upon his ability to instill fear in the employees to obtain results, are unnecessary. With a fair and equitable wage payment plan, employees are paid commensurate with their ability. This always means satisfied employees.

If anyone wonders just how any kind of wage incentive plan in the factory changes conditions so far as the superintendent's job is concerned, I will say, first of all, that I am not referring to a superintendent's personal bonus, although being on bonus myself I can vouch for the fact that it has the same beneficial effect on an executive that it has on factory supervision.

Our bonus plan helps me greatly because it permits me to receive, with practically no expense, a detailed report from each group showing their bonus standing at closing time the previous day. As the bonus percentage is a cost barometer, I can tell at a glance what group is in trouble. If their bonus is below what I consider a satisfactory figure, taking into consideration conditions as I know them to be at the time, the assistant superintendent and foreman concerned are called into my office and we go into the matter to see what has happened.

I obtain this information, which means that my costs are going up, the day after trouble shows up. Compare this with the usual method of obtaining information through the average cost department and you will quickly see that instead of perusing reports showing ancient history, we get control of the situation so early that, in most cases, we can apply an immediate remedy, thereby avoiding losses and high cost.

Another valuable effect of this report is that the foreman furnishing it to the superintendent daily is forced to keep a record of "allowed" and "taken" hours each day. Therefore he knows how his department costs stand at all times and is able to plan his work more carefully.

Our bonus plan also lets me receive in my office weekly a report

showing the number of bonus units delivered from each group or department. These figures are noted on charts which carry a record of production required. This shows at once if each department is delivering a total equal to requirements. By checking these parts with bonus percentage earnings I can tell at a glance if a foreman has too much or not enough direct labor. If the chart shows that deliveries are not up to requirements but bonus percentage is normal or above, then more help should be employed, or if the condition is temporary, overtime should be resorted to. If the charts show deliveries exceeding requirements, then help is either transferred to another group, hours are shortened, or help not up to standard is dismissed.

Our bonus plan permits the maintenance, in most cases, of a record of each employee's work. This is done with very little effort on the part of the foreman. This record, which is checked daily, shows the foremen which employees are not producing as they should. They can then be speeded up before much damage to the department bonus is done. Recommendations for increase in hourly rates also are based on these records.

The fact that each foreman each day is obliged to check the details mentioned relieves the superintendent of considerable work and worry. Every foreman knows that he cannot overlook these details a single day, for if he does, the reports coming to the office will show an unsatisfactory condition. He also is fully aware of the fact that his personal bonus depends upon his continual checking of everything entering into cost of production in his department.

Just as soon as a foreman receives his work orders or, as we call them, his rate sheets, he immediately checks to see how many man-hours are involved. This can be done in a couple of hours in any department, due to our simple method of figuring bonus units. He can then plan his work far enough ahead to permit him to increase or decrease his force as necessary. This relieves the superintendent of this phase of the labor and production problem to a very great extent. A foreman seldom tries to hire too much help or is excessive in his requests for wage increases, as too much help would eventually cause considerable trouble due to lack of work, and an increase in the average hourly rate reduces his own income materially. Nor will a foreman use a man on a boy's or girl's job, for a decreased hourly rate increases his personal income.

Due to the effect that improved methods and more efficient equip-

ment have on a foreman's bonus, new ideas are continually brought to me for consideration. If it were not for this valuable part of the bonus plan I am afraid that we would have to depend entirely upon cost reductions worked out either by myself or by men employed for this particular purpose, and we, of course, could not be expected to bring to light all the little things that a foreman gathers through his experience on a particular class of work.

Now that our factories are on bonus 100 per cent, when I am away from the plant for any cause I have a feeling that everybody is doing his best just the same as he would be if I were on the job. This, to my mind, is a very important feature.

We all like to think that most employees work hard for us because our company is a good company to work for and to a certain extent that is a fact, but we must admit that one of the main reasons why it is a good company to work for is because our wage incentive plan is satisfactory to everyone concerned.

PIECE-WORK IN OUR STOREROOM

By G. A. PENNOCK

Technical Superintendent, Western Electric Company, Incorporated, Hawthorne Works, Chicago

OF ALL methods of wage payments the most satisfactory is some type of piece-work. There are two usual forms: the payment of a certain price for every part produced; and the payment of a fixed rate with an additional bonus for every part in excess of a stipulated minimum, representing a fair day's work for average operators. Sometimes the piece-work plan is applied to the work of individual operators and sometimes it is based on the output of a group working together on the successive operations necessary to complete a unit part or a unit job. Among its advantages are that it pays every worker according to his efforts and abilities, so that the better workmen receive higher returns than the lazy or inefficient; and, from the point of view of management, it increases output without increasing investment or operating cost.

Desirable as it is, however, the piece-work system can not be universally applied. It is only applicable to repetitive operations, alike or so similar that the performance of each takes the same average time. A further consideration is the ability to keep accurate count of the number of parts produced or the number of operations

performed without having the accounting costs wipe out the economies obtained through piece-work operation.

At first sight both of these considerations would seem to preclude the possibility of piece-work payment for stockroom employees, whose duties consist in storing raw materials and apparatus parts, which they deliver over the counter in varying amounts as called for on orders. These difficulties have been surmounted by careful analysis at the Hawthorne Works of the Western Electric Company, which is now successfully running its storerooms on a piece-work basis.

This big plant, the world's largest telephone manufactory, occupies a 200-acre tract that straddles the west boundary of Chicago. Its buildings have a floor space of 87 acres (3,790,000 square feet) and its employees number about 25,000. In a plant of this size it is imperative to secure the utmost possible efficiency in storage, so that parts or raw materials may be obtained promptly by the departments requiring them in their operations.

The storage problem at the Hawthorne Works is decidedly complex. The factory makes more than 110,000 different parts, using 18,000 kinds, shapes and sizes of raw materials. Of these items 65,000 are handled in the 42 storerooms, located at various places in the buildings where they are most convenient to the particular manufacturing departments they serve.

The materials carried in these storerooms range from parts so small that several thousand would be but a handful, to articles weighing several tons each. Some are stored in bulk, others in special containers, such as pans, trays, crates, barrels, and bottles. Moreover, the storerooms handling raw material are equipped with machinery to cut it to the size required. This equipment consists of shears, slitters, rod cutters, cold saws, and similar machinery. In other words, the function of these storerooms is not merely the handling of material, but is further complicated by the inclusion of mechanical work.

The storeroom organization employs 350 people, both men and women. Except for the machine operators, the class of help hired is usually inexperienced in this particular field.

When it was first proposed to pay them on a piece-work or incentive plan, it was realized that some basic elements would need to be developed, since, as far as could be ascertained, no similar incentive plan was in use anywhere. In general, other manufacturers held

the opinion that storeroom work is so diversified as to make it impossible to determine a sound basis on which to establish piece rates. However, since a large number of people were involved and the possibilities of economy seemed good, an extensive study was undertaken to determine the feasibility, and to compute the economies of piece-work payment.

The first big question was the establishing of some practicable method for determining credits. Piece-rate systems already established in the Hawthorne Works provided for crediting operators from an actual count of their output, made by an independent counting unit after inspection. Under such a system the crediting is a simple matter of posting the count on a combination delivery and credit ticket. It was obvious that this plan would not be feasible for storeroom credits. The large amount of work necessary to inspect, count and credit each operation would be impracticable from a cost point of view, and furthermore would delay the service rendered by the storerooms.

A review of the factory's storeroom methods showed that one factor was common to all transactions, namely, the identification ticket, which invariably accompanied the material whether it was being brought into the storeroom or taken out. For instance, tickets sent with material delivered to the storeroom indicated the amount of material delivered and the number of containers used, while tickets issued by the manufacturing departments for drawing stock from storerooms showed the kind of material and the amount requested.

A long series of time studies showed that the information on the tickets could be used as a satisfactory basis for rendering piece-work credits to the storekeeper. If small quantities of material are handled and the time involved is not materially affected by the quantity, payment should be made on the basis of the number of tickets.

Sometimes the number of containers handled should be the determining factor. When the material is handled in containers the credit is already established on the delivery ticket, since the counting organizations specify the number of containers at the time credit is given to the operator.

In other instances the weight of the material, which is also shown on the ticket, is the basis for piece-work credit.

Storekeepers are, therefore, credited with material received into or delivered from the storerooms on the basis of the information contained on the tickets.

All tickets for material delivered or drawn are forwarded from the storeroom to a clerical unit, which analyzes and prices the tickets for payment. The work is carried on by associating the tickets with the information contained in a file of approximately 1,800 rate cards, covering all conditions which arise in storeroom work.

The gang piece-work system was found best suited for storeroom conditions. In this plan, payment is made on the combined output during a given interval. The total piece-work value earned by the gang is determined at the end of each week by multiplying the piece-rate for each class of operation by the number of such operations performed. The unit rates have allowances for training new help and for supervision. The piece-work value of the gang's output is prorated to the operators in proportion to their hourly rates and the number of hours worked.

A plan of this kind allows each member of the gang to make about the same bonus over his hourly rate consistently day in and day out, and permits the rotating of men from one job to another without affecting their earnings.

The use of piece rates in the storerooms has resulted in mutual benefits to the company and its employees. Among the advantages obtained are: increased earnings on the part of the operators; decreased cost of operating storerooms due to increase in efficiency of operators; standardization of material handling practices; reduction in supervision; reduction in labor turnover.

This successful experiment proves that, with careful study, it is possible to establish an incentive plan for all classes of work where a unit of measure can be established, provided the volume of the work is sufficient to cover the cost of the investigations.

USES AND LIMITATIONS OF GROUP INCENTIVES

By R. F. WHISLER

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IT HAS been said that a difference of opinion makes horse racing popular—and expensive. There is much in this article on which the opinion of the reader may differ from that of the writer. However, the statements made herein are submitted as a recital of experiences and not as an argument.

In the conveyorized assembly of wood cash drawers we find a splendid example of the kind of job best done under a group piece-work plan. Groups of ten to fifteen men seem to function best

Things are good or bad only by comparison and in this discussion the writer will compare and refer to results and practices of group or individual incentives as well as daywork payment plans. Because of these comparative experiences, the opinion has been formed that group incentives have limitations as well as advantages.

Our field for time-study analysis and incentive wage plans has been unlimited. The factory with 425 different lines of work has in active production over 44,600 different parts which involves 500,000 detail operations, 91 per cent of which are paid for by piece-work, group or individual. National Cash Registers are among the most complicated machines made, involving precision methods and the highest quality workmanship in quantity production. Some of the models have nearly 12,000 parts, many hundreds of which go through a complete cycle of operation in a few seconds' time.

National Cash Registers have been made for nearly 50 years and piece-work has been used to a great extent for nearly 40 years. In the early years of the business, the contract plan of employing and compensating labor was in effect. The company policy has always been to apply the incentive wage wherever practical. Up to 1924,

Our experience shows that where each operator completes his operation and the work passes on to the next department, individual piece-work is the most satisfactory method of payment

"straight" or "individual" piece-work was in use, with a few "gang" jobs on which it was impossible to separate the individual production. In 1924 the wide use of the "group bonus" plan in automobile plants caused the management to have it investigated. Trial applications were made to see if the advantages claimed by its users could be realized in our type of manufacture.

In adopting group bonus we set up the following list of objectives which we felt that it should accomplish: 1. Pay a fair day wage for a fair day's work; 2. reduce labor cost; 3. maintain high standards of quality; 4. simplify and reduce clerical cost; 5. speed up stock turn and reduce process inventory; 6. foster cooperative spirit and effort; 7. retain incentive of individual piece-work plan; 8. train new employees quicker and better; 9. develop better supervision material; 10. reduce overhead or cost of supervision.

For about three years we used the time basis plan:

1. Standards expressed in decimal hours per 100 units and based upon time study.

2. The performance of an average experienced worker, having knowledge of the job and working at normal effort under good conditions was considered 75 per cent efficient.

3. Bonus started after attaining 75 per cent efficiency. One per cent bonus was paid for each one per cent in excess of 75 per cent efficiency.

4. This is a gain sharing plan, the company receiving one-fourth of the actual increase above 75 per cent. For example, to raise the efficiency from 75 per cent to 100 per cent requires 33-1/3 per cent increase in output but will pay 25 per cent bonus.

5. Efficiency is the ratio of the group output to the group input, in hours.

6. Members of the group are given guaranteed rates, graduated according to their individual skill, speed, responsibilities, and relative value to the other group members. Individual rates are adjusted as needed.

7. Group leaders are appointed for each group.

8. Where more than one operation is done on a part or assembly by a group, one standard covers all work.

9. Groups are credited with accepted work; re-operation is on their own time.

10. Group bonus on inspection work contains a quality allowance. If this is exceeded, the group suffers a penalty but if rejections are

Example of Time Standard Plan

GROUP BONUS SUMMARY—GROUP NO. 18

Ck. No.	M	T	W	T	F	S	Total Hours	Rate	Day Wage	% Bonus	Bonus Earn's	Total Wage
222	9	8	7	8	9	5	46.0	.60	$27.60	36.0%	$ 9.94	$37.54
333	9	9	9	5	9	4	45.0	.50	$22.50		$ 8.10	$30.60
Total							91.0		$50.10		$18.04	$68.14

Standard Hours	Actual Hours	Efficiency %	Bonus %	O.K.
101	91.0	111.0%	36.0%	R.F.W.

below the limits allowed, a bonus is earned in addition to that for quantity of output.

Ck. No. 222 is the operator; Ck. No. 333 is the helper; for the sake of illustration, the time worked by each is varied. The group produced 505 pieces at a standard time of .2 hours each; the actual hours worked were 91.0.

Dividing 101 by 91 gives the ratio of the output to the input or

$$\frac{101}{91} = 11.0\% \quad 111.0\% - 75\% = 36.0\%$$

bonus earned. Thirty-six per cent of each man's day wage earnings equals bonus earned. Bonus plus day wage equals total earnings.

In actual practice, production and attendance records are kept on a weekly basis and bonus computed and paid weekly.

During the three years that these ten principles were in operation we struggled to overcome five great handicaps of this form of group bonus: 1. Difficult for employees to figure; 2. foreign to our cost system; 3. costs were subject to changes in individual day rates; 4. cost fluctuated with group efficiency; 5. standards were not interchangeable with our individual piece-work system.

These interferences became increasingly greater handicaps to successful operation of the group plan, which in general had proved its value to us. In finding a solution to our troubles we made the following modifications in our original group bonus plan: 1. Changed basis of bonus from 75 per cent to 100 per cent—eliminating the gain sharing feature. One per cent bonus for one per cent

Example of Money Standard Plan

GROUP PIECE-WORK PAYMENT SUMMARY—GROUP NO. 18

Emp. No.	M	T	W	T	F	S	Total Hours	Day Rate	Day Wage	Bonus Factor	Bonus Earn's	Total Wages
222	9	8	7	8	9	5	46.0	.60	$27.60	1.3609	$ 9.94	$37.56
333	9	9	9	5	9	4	45.0	.50	$22.50		$ 8.10	$30.62
Total							91.0		$50.10		$18.04	$68.18

Group Wage	Group Earning	Bonus Factor	O.K.
$50.10	$68.18	1.3609	R.F.W.

in excess of 100 per cent efficiency; 2. replaced time standards with equivalent value expressed in money—corrected to 100 per cent basis for earning bonus; 3. same as time plan in all other details.

The group produced 505 pieces, at a price of $13.50 per 100, equals $68.18. The day wage earnings were $50.10. Under the money basis plan, we express the bonus per cent as a factor—in

order to apply it directly to the day wage earnings and find the total wage. The bonus factor above is 1.3609 found by dividing $68.18 by $50.10.

These changes seemed to solve the difficulty and we soon had more than 1,000 people in 100 groups working on the new money standard plan—or, in reality on "gang" or group piece-work. We call our plan "group piece-work" because gang piece-work involves only the split of the earnings on an even basis, while our new group plan recognizes individual worth and leadership.

The most outstanding results were found on work formerly paid for on a day-work basis. Individual piece-work would also have brought about many of the results which group piece-work has. However, the individual plan has one drawback which our group plan removed, namely, the difficulty of fixing definite individual standards for payment on certain grades of work.

In changing individual piece-work jobs to group piece-work the principal gain has been in absorbing and reducing the indirect labor such as helpers, truckers, clerks, job-setters, adjusters, and so on, who formerly were on day-work. Our experience as a whole does not indicate that a well balanced, fairly priced, individual piece-work job, wherein men are working on non-continuous work, (such as punch presses) will show increased production on the group plan. We have better results where men run groups of machines (three or four power mills, four to eight screw machines) because they can relieve each other during various emergencies which cause a machine to "run-out" before the operator can get to it. When replacing individual piece-work with the group plan we set up the actual past records, and, if no changes are made to reduce piece-work prices, we pay the same to the group, and give each member of the group a base rate that will pay him, on a group basis, approximately his earnings on an individual basis. Later each member's production is checked and if not equal to the former records, his base rate is changed to correspond with the amount he is contributing to the group's results. Some showed improvement and their base rates were raised, others were lowered.

Under group bonus, increasing the base rates of the group increased the cost, but under group piece-work the costs are set and remain unchanged.

The supervisors over the departments working on group piece-work must be in sympathy with the plan, for the foreman's attitude

toward the plan will influence those under him. A clear understanding by all concerned is the cornerstone of a successful wage incentive system.

We have found that groups not exceeding 15 employees, with 10 a good average, will function best, remain interested, cooperate, and have less labor turnover, although larger groups will be good on continuous process or where the group leader or job-setter has contact at regular intervals with members of the group.

Our experience has been that groups composed of women are hard to keep "settled." More dissatisfaction seems to develop among women. Sometimes this expresses itself in petty jealousies, or a fear that they will do more than their part. Groups of women require closer and more constant supervision than men, and some that we have returned to the individual plan, have shown increased production and better conditions in general. Groups composed of men and women have worked well, but principally because of the continuous, or conveyorized process.

It seems to us that the conveyorized process offers the best field for group piece-work or bonus because the very momentum of the flow of production keeps the individuals alert to their duty and compels them to hold up their end of the work. It also provides the field for group or cooperative effort and makes group payment practically a necessity.

One of the best results we have secured from the group wage plan has been the providing of a means whereby the lower rated day-workers had a chance to increase their wages while operating at less than day-work cost. There are certain jobs which, under day-work, were paid 45c per hour. This seemed to be the correct rate considering skilled trade rates, labor supply, conditions, and so on. Many of these men are now earning as much as skilled production mechanics, and this has had no tendency to unsettle the attitude of the skilled man, for he can see the physical effort required in the volume of work done, and he knows by his own experience that under piece-work you have to produce or you don't earn. Under day-work, if we had increased the day-rates of the non-producers or indirect labor, then all labor rates would be open to revision, at least in the minds of the men, and dissatisfaction would have resulted.

There is one fault which we corrected only by reverting to individual piece-work. This fault probably was more emphasized in

our plant because of our long history of successful operation of the individual piece-work plan. While we laid our plans carefully to provide for recognition and reward of the individual's relative value to others in the group, we soon found that the faster operators tapered off from their previous individual records, and the slower operators showed little improvement, if any, with the result that

Although this kind of assembly work may be done under either group or individual plan, it is advantageous to employee and company to use the former

the earnings and production of a group became less than on individual piece-work and slower operators were somewhat overpaid and the faster operators were underpaid.

The principal reason for this, as we see it, is that in a group of ten or twenty men, one man can increase his production and not be directly and immediately rewarded, while another man feels that he can slow up and still get a good share of the group earnings.

After operating six months to two or three years, these attitudes developed among the men and production suffered.

Then came dissatisfaction among the men because of decreasing wages. Now, someone will say "only a question of supervision to prevent or correct this condition." Which is true to a certain extent. Many of our foremen overcame this condition through closer supervision and detailed checking of the individual records. But what have we then? A new problem of supervision which would not be needed on the individual piece-work plan. May I repeat that this problem is strongest where group replaced individual piece-work and on work of an individual nature? Where day-work has been replaced by group work, these problems almost never arise. These former day-work jobs are generally of a "collective" nature and most adaptable to group work.

With all our theories and practices of giving the individual in the group a base rate in keeping with his value to the group, and in spite of the fact that our check-ups showed that the members of the group were actually being paid approximately what they earned each week on their own operation, using the standard price for each operation, the men still expressed a strong desire "to work for themselves and earn their own money." This attitude is probably due to influences such as a long experience of individual piece-work; a large percentage of the work is done on individual operations and not in continuous methods; the product itself is built on an individual basis, there being hundreds of kinds and sizes; the tendency of the group plan to share equally all earnings in the group; or the presence of individual piece-work jobs in or near group jobs.

Another problem encountered in replacing individual piece-work with the group plan in our plant was that the men could not be told their weekly earnings until all time tickets were computed. Then the attendance, hourly rates, and time spent on each group by the various members had to be checked and from these the group earnings were found, and subsequently the individual earnings. This was not obtainable in some groups until Wednesday of the week following the job's completion. Of course, in some classes of work where only a few jobs were run in a week's time, the earnings were soon found, but, where a group finishes several hundred jobs requiring individual computation for each, it is not so easy.

Therefore, after many experiences, some very profitable, others of doubtful value, we find ourselves replacing many group piece-

work jobs with the former individual piece-work plan. But we have retained many group jobs, and are installing still more. The group piece-work or group bonus plan has its place, but conditions must be right for its successful operation. Our experiences are summed up in the following:

1. Where a number of people complete a part or job by a series of operations in a progressive manner, generally with the aid of conveyor, group incentives are best. In some instances they are necessary. Assembly lines are good examples of this class of work.

2. Where machines are operated on a multiple basis (more than one machine per operator) and there are several operators, group incentives are applicable. Automatic screw machines and power mills are examples of this class.

3. Where work is performed by a number of people working collectively and the individual's output is not readily obtainable, group incentives are necessary. Labor gangs, material handlers, groups operating plating machines, woodworking machines, stokers, are examples.

4. Where each operator completes his operation without aid of others and the work passes on to the other departments, individual piece-work is best. Punch presses, drill presses, sub-assembly departments are examples.

5. In general, we believe that the individual incentive is productive of more consistent results and satisfies a man's desire to "work for himself"—with the result that the workmen are better satisfied.

Where conditions permit its use, the individual piece-work plan provides lower costs, better wages, greater satisfaction and is more acceptable than the group plan. But where it is impossible for any reason to put it into effect, the group plan is effective, and certainly far more satisfactory than day-work. It so happens that most of the operations in our plant lend themselves to the individual piece-work plan. In fact, the very product itself is individual, so that we have found this incentive plan the most adaptable to our manufacturing conditions.

PRODUCTION STANDARDS SET UP THROUGH TIME STUDIES RESULTED IN HIGHER WAGES AND LOWER PACKAGE COSTS

By THOMAS R. HOUGH
Manager of Methods and Production, Wilson and Company, Chicago

QUITE a part of the price of the bacon you may have eaten for breakfast this morning is represented by the cost of the attractive container in which it came from the market, and in the various other package and packing costs involved in getting it to

"The product passes in sequential order from end nailer to framer, to bottomer and finally to conveyor"

your table in its most appetizing form. It fell to my lot to assist in reducing these packing costs, by reorganizing the box factory of our company.

A large variety of sizes and kinds of wooden boxes was produced and considerable flexibility was necessary in production and distribution in order to insure uninterrupted production and consistent earnings on the part of the men. The work had been done on a day-work or guaranteed hourly wage basis.

We found it necessary to do two things in order to bring production costs down to a more economical basis. First, we made a number of changes in the layout of equipment and methods of handling the work. In the second place, we worked out logical and accurate performance-time standards and put into effect a plan of group-bonus payment based on these standards. In the two years since these changes were made, the savings have amounted to nearly $9,000—$8,690, to be exact.

In the packing-box department there are three logical main groups of workmen. One of these groups unloads the raw materials, the lumber shooks and nails. Another group prints the box sides, assembles the boxes and runs the nailing machines, and inspects the finished packages. The third group trucks the finished boxes to the various departments which have placed orders for them. In addi-

tion to these groups there is a small salvage and repair gang which reclaims containers damaged in handling.

The three batteries of nailing machines in the department were operating on a vague daily-output estimate or expectancy. Each group of machines maintained its own inspectors to guarantee good workmanship, and boxes were trucked to a chute from which they went to the wagon loaders.

Cars of incoming materials were unloaded and stored with that degree of speed and enthusiasm to be expected when the only incentive to effort is watchful supervision. Then men who trucked boxes to the ordering departments were moved to action mainly by fear of complaints from departments waiting for boxes, or by the ire of the box-shop foreman when he discovered distributing centers congested with undelivered boxes. The shop had all the earmarks of being ripe for a general overhauling of methods.

The first action taken was to concentrate the product from each nailing machine assembling unit at a centralized inspection bench. To facilitate this change a gravity roller conveyor was installed to carry the boxes to the inspection bench. This change disposed of four of the six inspectors previously required.

A new two-way box chute was also installed in place of the old chute, to take the boxes after inspection. With the old single chute it was necessary at times to hold up the trucking until the loaded

Old chute at right was used before the introduction of the two-way chute and concentrated inspection bench

Boxes are carried to the inspection bench by a roller gravity conveyor

wagon was removed and a new one could be spotted alongside the chute. The two-way chute eliminated this delay and thus reduced labor costs.

Reducing the lost motion which was apparent in the physical layout left us ready for time-study work to set up production standards, which in turn would become the basis of incentive-award payment.

First we classified the boxes as to size, kind, difficulty or ease of manufacture, and allocated these classes by group numbers to the units best fitted to make them.

Time studies were then taken upon the work being done at each work station. The data secured from the time study of each operation upon a box or crate of a given group were accumulated, and synthetic operation standards were developed—formulas, in short, on which time standards for payment could be based. The plan used in the box department is indicated by the formula illustrated.

The time standards thus developed indicated the number of persons required to carry on the production program, and by inference, would point out any necessary reduction in force.

We were now prepared to put these standards into effect to measure the productive efforts of the gang. At the start it was necessary to coach the gang carefully, and, with the helpful cooperation of

Formula for Box Making

Box Numbers

Description

Dimensions | | | | Job No.

OPERATION SEQUENCE	Time per Unit	Units per Box	Time per Box	% Standard Allowance	Standard Allowance Time	Standard Time per Box	No. Men per Operation	Standard Man Min. per Box
Stock Up Sides								
Stock Up Ends								
Stock Up Cleats								
Stock Up Bottoms								
Load Covers								
Printing								
Cleating								
Framing								
Bottoming								
Inspection								
Load Wagon								
_____								
_____								
_____								

Total Standard Time per Box — Minutes

Standard Number of Men in Gang

Standard Hourly Production Schedule — Boxes

Remarks:

"Time studies were taken upon the work at each station, and operation standards were developed upon which payment could be based"

Formula for Box Delivery

Box Numbers

Description

Dimensions | | | | Job No.

Deliver to — Dept. | Route No.

Load and Prepare Truck	_____	Min. per Box
Unload and Pile Boxes	_____	Min. per Box
Number of Boxes per Load	_____	Boxes
Total Box Handling Time	_____	Min. per Load
Distance to and from Dest'n	_____	Feet of Travel
Standard Trucking Time	_____	Min. per Foot
Total Trucking Time	_____	Min. per Load
Standard Elevator Waiting Time	_____	Min. per Elevator
Number of Elevators Used	_____	Elevators
Total Elevator Waiting Time	_____	Min. per Load
Standard Elevator Travel Time	_____	Min. per Floor
Number of Floors Traveled	_____	Floors
Total Elevator Travel Time	_____	Min. per Load

Total Box Handling Time	_____
Total Trucking Time	_____
Total Elevator Waiting Time	_____
Total Elevator Travel Time	_____
Total Load Delivery Time	_____
Number of Boxes per Load	_____
Standard Box Delivery Time	_____
Standard Production per Man-Hour	_____
Number of Men in Standard Gang	_____
Standard Production per Hour	_____

Remarks:

"Time studies were taken upon the work at each station, and operation standards were developed upon which payment could be based"

the foreman, to pay special attention to maintaining good working conditions, clear aisles, trucks and equipment in good order, clean surroundings and so on. Eventually the standards were met, and in due time they were exceeded by a comfortable margin. We no longer needed to rely on supervision to secure satisfactory output of standard quality; the bonus provided the necessary incentive.

To emphasize the extra bonus which resulted from extra effort we used separate checks for the hourly and the bonus earnings. We also developed a "bonus bulletin" which was posted every day and showed just what the gang had earned the preceding day.

The foreman's activities in aiding the gang to secure production were stimulated by the fact that our wage plan provides for bonus awards to indirect workers who aid in attaining and then maintaining a high departmental efficiency. The supervisory force is found in this group and the interest taken by the foreman and his assistants in the gang accomplishment gave good evidence of the efficacy of such indirect bonus awards.

For direct-payroll employees the wage system was a 100 per cent payment task-and-bonus plan with guaranteed hourly wage rates. These wage rates were set after careful job-analysis and occupational rating.

The compensation for indirect workers was based on the efficiency of the employees directly affected by their aid. A scale with

The inspection bench is at the head of the two-way chute leading to the wagon loader

varying increments of value, expressed in percentage of elapsed-hour earnings or salary for the period, is used as the medium of determining the bonus earnings of indirect and supervisory workers.

It was necessary to work out standards for each gang. However, the time of the installation engineer was greatly economized in this work by the working out of a formula for box- and crate-trucking standards, as was done in the case of the box-making gang. The advantage of a general formula for our trucking operations is obvious when you consider that the same truck may carry 200 pieces per load or only four, that distances trucked may vary from 400 feet to 1,200 feet, that some boxes may be nested and others cannot, and that as many as three elevators are used on some trips and none at all on others. The trucking formula is also reproduced in one of the illustrations. The trucking gang was in charge of a working supervisor. It was interesting to note the change of attitude of this gang when they were put under the incentive plan.

Elevator delays are always numerous in heavy production. Under the old method if the elevator operator failed to "pick them up" on their trip the men felt that it was no fault of theirs. It was discovered in studying out the problem that the elevator operator was often not advised of their presence. As will be readily obvious, to control temperatures for food preservation, fully closed elevator doors are essential. Therefore, unless the persons requiring elevator service notified the operator, they might wait there for a considerable period of time.

In the course of the study standard, elevator-waiting times were established and these were included in the total time in the development of trucking standards. Upon application of these standards to the gang performance, it no longer required supervision or even instructions to cause the truckers to realize that unnecessary elevator-waiting time reduced earning possibilities.

Take it altogether, a substantial benefit resulted from this study of packing methods. Not only was there the considerable money saving already mentioned, but employee earnings were increased and departmental-labor turnover was reduced. Arguments about wages were reduced because a logical basis for payment had been found. Better quality and a more consistent flow of work were secured because of the elimination of much unnecessary supervisory detail, and the consequent increased concentration of the supervisory force on the necessary detail which remained.

BECAUSE WE PAY A BONUS, OUR MAINTENANCE MEN FIND NO TIME TO LOAF

By H. O. McDONOUGH
Superintendent, Monsanto Chemical Works, St. Louis

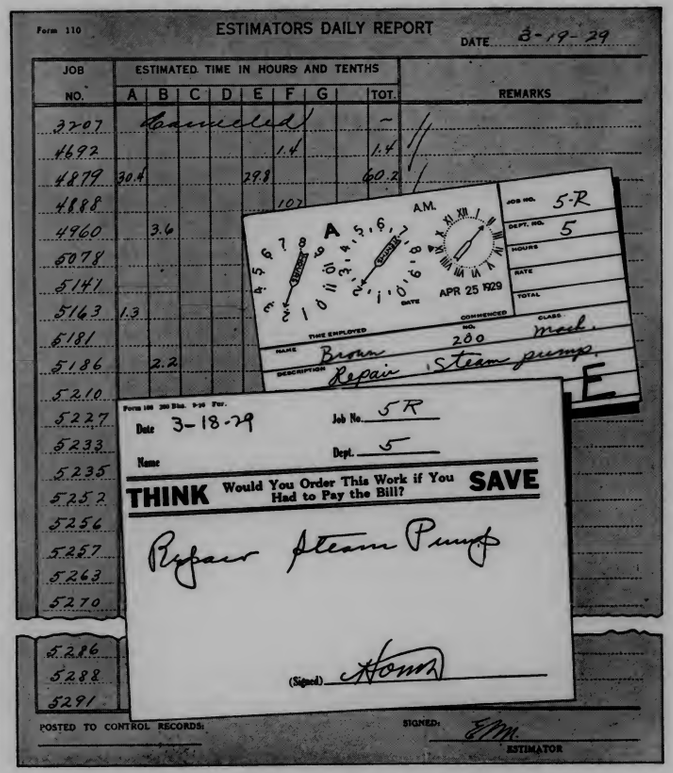
MAINTENANCE is one of those phases of manufacturing with which, in all its details, production management cannot hope to keep in active touch. But because maintenance forms an important item in arriving at unit costs, management should set up an executive control of maintenance costs—if it is to have a true picture of manufacturing activities.

When you come right down to it, there is no earthly reason why a mechanical department more than any other should be run in a slipshod manner. But oftentimes it is, presumably because there is so little of a repetitive nature that it is difficult to gage accurately just how much work each man ought to turn out. We found, for instance, that the bonus system which worked successfully in the packing department and in the warehouse, didn't work at all in the maintenance department—didn't work because, by the very nature of the jobs, standardization was impossible.

So we developed a new incentive system with the mechanical department in mind. It was important that we should work out such a plan because we felt that, given incentive, the men in that department would apply themselves more whole-heartedly to their work. In short, we figured that we would benefit by increased production, while the men might expect fatter pay envelopes. Which is just the way things have worked out. And lest it be thought that I have laid undue stress on the importance of this development, let me point out that in our plant the mechanical department constitutes about 30 per cent of the working force—right around 140 men at the present time.

The system as we applied it is built around an estimator who figures the labor required for every job, large or small. Based on his estimates, we either pay or do not pay a bonus. There is no delay, for estimates do not necessarily have to be made before the job is started. They may be made while it is being done, even after it is done. It makes no difference, because the estimator is for the most part kept in ignorance of the actual time put in so that he won't be influenced one way or the other.

Obviously, it would be next to impossible to keep track of every



Labor costs are estimated for every job, large or small. Based on these estimates, we either pay or do not pay a bonus

single job. At least the mass of paper-work needed would more than offset the advantages of the system. So for the sake of convenience and simplicity, the men are divided into groups: (a) pipe fitter; (b) salvage men, carpenters, painters; (c) coppersmiths, tinners, welders, lead burners; (d) riggers and millwrights; (e) machinists; (f) electricians; (g) garage men (two only).

In actual practice, the estimator figures how many hours it will take each group to do its part of the work on any particular job.

Then at the end of each week, the estimates are recapitulated and compared with the actual working time taken by each group. If the group has kept within the estimated time, it gets a bonus. Should it exceed the estimated time, it is paid at the regular rate.

On minor jobs, that is to say, on jobs where the cost will probably be under $25, the system works something like this: A steam pump in department 5 has to be repaired. The foreman of that department makes out a requisition and sends it to the master mechanic who assigns a man to the job. A job ticket is made out and the starting time is recorded. The ticket is stamped again when the job is finished and elapsed time is automatically registered. A notification goes to the estimator, and he chases up the job and figures the labor. Both this job ticket and the estimate are forwarded to the bonus department, and compared at the end of the week.

With major repairs, the principle is the same. Each job is kept separate, however. And each job is figured by the engineering department before work is started. If the management decides to go ahead, the labor estimator figures the labor for each group much as he does for minor repairs. He works independently of the engineering department, and of course his estimate is for labor alone whereas theirs includes materials.

As for results, we are not quite sure what this incentive plan is saving us in actual dollars and cents. But we do know this. The cost of labor compared with the cost of materials used has gone down, indicating that we are making money. Another thing. The men telephone in when a job is completed, at least when it is in a remote corner of the plant. They lose no time clocking off one job and on another.

Then there is the additional favorable evidence that bonuses average around 4 cents or 5 cents an hour per man—about $2.50 a man for a 50-hour week. We know the men keep busier, and also make more money.

Those are the advantages. The paper-work is simple and inexpensive to keep. In fact, the only possible disadvantage I can see is that the system depends more or less on the estimator, that the personal equation plays a fairly large part in its working out.

Anyway, we are quite sure that we shall never go back to the old way of paying the mainteance men. We are not satisfied that ours is the very best way of running this department, but at least we are certain that we have taken several steps in the right direction.

PROFIT-SHARING—AN INCENTIVE PLAN FOR EXECUTIVES

By C. C. BALDERSTON
Assistant Professor of Industry, University of Pennsylvania, Philadelphia

THE effect of a financial incentive on the output of manual workers has been known for years. Ever since piece work was first introduced into the shop, incentives for workers have been recognized as an important tool of management. Since managers exert a greater influence on profits than manual workers, it is even more important that their method of payment should call forth their best possible accomplishment. Why should the compensation of major and minor executives not be contingent on results rather than on time worked? Why should we rely upon the hope of promotion to stimulate management rather than upon a more direct incentive?

Recent years have added another reason for asking this question. The wide distribution of the holdings of common stock in many companies has resulted in a situation where the managers do not have important holdings of stock. This condition is the opposite extreme from the partnership. In the latter form, a pecuniary interest in the business was a constant inducement to maximum endeavor and to close attention to details. The coming of the corporation, with its advantages in other directions, did not immediately destroy the use of the proprietary interest as an incentive, because the holdings of common stock were often concentrated in the hands of those who were active managers, or were close to the direction of the business. Today the situation may be different. In large corporations, the amount of stock actually owned by operating executives, or even by members of the board of directors, may be so small that their dividends offer but little stimulus.

It is impossible for all of the common stockholders of one of our corporations to know personally their representatives on the board of directors. But even if these investors are represented by able directors, they still need the added security of having the operating management actively interested in maintaining continuous earnings.

That part of an executive's compensation should vary with his results is not only good business for the owners, but is equitable for the managers. Payment contingent on the success of the company enables a corporation to set up for its executive group one of

the valuable features of the partnership—that each should take out of the business in the proportion that he has contributed. This idea is difficult of accomplishment with straight salaries. Contingent payment gives to the managing group part of the results from their skill and effort. It seems altogether fair that, since large companies need for their effective direction men of sufficient caliber to go successfully into business for themselves, they should have the opportunity to secure as managers, rewards comparable to those which they give up when they forego becoming proprietors of their own concerns.

The mere use of a phrase such as "stock ownership" is not a remedy to this situation, because a *small* proprietary interest may not inspire action. Furthermore, one who holds only a few shares out of several hundred thousand must fully recognize that he can exercise no effective influence over the business. If the stock should shrink in value, his investment may prove just the opposite of an incentive.

Since stock-ownership by itself does not seem to be a complete answer why is there not a method of financial incentives for executives which will act as a direct spur? The difficulties which have blocked such executive incentives are:

1. The lack of a clearly defined task for each manager.
2. The feeling that a precise method of measuring results was impossible.

As a compromise solution, many companies set out on the easiest path by giving bonuses on an indefinite basis. In many cases these indefinite bonuses are said to be satisfactory. Undoubtedly, they are better than nothing if carefully and wisely administered, but an observer cannot help feeling that they offer a poor substitute for a real incentive. They lack all the fundamental elements of a good plan. Granted at the whim of the board of directors and announced after the completion of the job, these bonuses have a low "pulling power" because of their uncertainty and the fact they have no direct relation to any objective measure of results. What manager would let a piece worker complete his job before telling him his piece rate?

A real managerial incentive must pass certain tests:

1. The basis of payment must be known to the managers in advance and reports issued of progress and results. It seems reasonable that a man will work hardest to gain a reward when he is told clearly, and in advance, the conditions under which he will win or lose it.

2. If managerial positions are mutually interdependent, the form of payment should emphasize the cooperative effort of a group as a whole as well as stimulate the initiative of the individuals.
3. The unit by which results are measured should be tangible; influenced as little as possible by factors beyond management's control; and should coincide with the best interests of owners, workers, managers and consumers.
4. The distribution among the individual executives must be considered fair by the consensus of opinion of those who know about it. The earnings must reflect the relative value of each man's contribution.

How successful have predetermined profit-sharing plans proved in practice? Of more than 65 plans which I have examined that are confined to managers, I have found only four which have failed because of dissatisfaction with them. Neither is the small percentage of failures to be accounted for by the newness of the plans investigated. In fact, the average age of 32 well-known plans, of which the starting ages are available, is about 11 years, and 14 of the plans are over 10 years old.

Although executive profit-sharing is used by large, medium-sized and small concerns, a list of the companies which use it is dominated by those which are well known for their success and good management. These include the General Motors Corporation; the E. I. DuPont de Nemours Company; the Dennison Manufacturing Company; the Leeds and Northrup Company; the American Rolling Mill Company; the F. W. Woolworth Company; the Walworth Company; and the Studebaker Corporation.

Does managerial profit-sharing meet the requirements we have set up for an ideal managerial incentive, and to what extent may a profit-sharing plan be announced as a definite arrangement?

1. It is possible to tell the participants at the beginning of the profit-sharing period that they are eligible, in case there are profits to share.
2. The deduction from net earnings for the protection of the common stock and for payment of bond interest and dividends may be approximately defined. However, it is necessary for the participants to accept the audited profit-and-loss statement, and it is often advisable for the board of directors to set up reserves to meet emergencies. Both of these affect the profits on which the bonuses are computed. It is desirable that, so far as possible, the nature and the probable extent of such factors likely to influence profits, be fairly definite in the minds of eligible participants.
3. The form and time of payment can be absolutely definite. It

THREE TYPICAL PROFIT-SHARING PLANS

Name and Address of Concern	Who Are Eligible to Participate	Basis of Determining Size of Management's "Fund"	Basis of Apportioning Management's "Fund"	Form of Payment
THE STUDEBAKER CORPORATION, South Bend, Ind. (Plan first dopted 1915).	All executives, senior and junior. Includes all who have any responsibility for spending Studebaker's money, for the commitment of the company to an obligation, or to the management of employees.	After 7% on preferred, a special surplus account for amortization of preferred, an amount equal to $5 per share of common outstanding, and income taxes, 10% of remainder to bonus fund.	According to importance of position held and contribution to profits as judged by the operating committee.	All or one-half paid in cash. If one-half is withheld, it is paid in stock, one-quarter the first year, one-quarter the second year and one-half the third year.
THE LEEDS & NORTHRUP CO. (Electrical instruments), Philadelphia, Pa About 600 employees.	Chief executives, factory management and salesmen (large part of sales force). Additions to or changes in participating groups subject to approval of executive committee. Basis of selection: ability to increase fund through increased effort and initiative.	After 8% interest on preferred, and 6% on present value of common (as determined from earnings by formula), remainder split empirically between common stock and management groups. Progress to date is reported to each participant monthly.	Bonus of higher sub-groups is larger, both absolutely and relatively, than bonus of lower sub-groups. Total of salaries in each of the six sub-groups is multiplied by a factor to determine share of that sub-group in the fund or "pot."	Cash, annually, but stock may be substituted at discretion of company.
BANK OF ITALY, San Francisco, Cal.	There is no distinction between the managerial group and other salaried employees. Each one's share, however, is based on his salary and length of service.	After deducting from the net receipts of the bank all operating expenses, all normal dividends, and all proper reserves, 40% of the remaining net to be used to purchase stock for employees.	The share of the profits distributed depends on three factors—length of service, salary, and the amount which he wishes to add to the portion which the Bank gives him.	The payment takes the form of stock of the bank, credited to the employee semi-annually, but paid out through the operation of the savings provision.

can be clearly understood that the payment will be either in cash or stock and will be made as soon as convenient after the closing of the books.

4. The apportionment of management's fund among the individual participants presents a critical problem. If it is decided to base the earnings on salaries, the method of distribution may be announced in advance. However, if it is desired to keep the bonuses independent of salaries, so that they will reflect performance only, it is necessary to announce the proportionate shares in order to have the plan predetermined on this point. Although this arrangement works satisfactorily after a plan has been in operation for a few years, the long time interval between effort and reward offers difficulties when first installed. For this reason, it may be decided to determine the individual shares after the period is ended, in which case the method of apportionment could not be definitely announced in advance.

It is possible to make managerial profit-sharing fully predetermined with some reservations in regard to the method of arriving at net earnings. But at the time the plan is installed, it may seem wise to compromise in the matter of determining the individual bonuses with this ideal of complete definiteness in advance.

Is managerial profit-sharing group payment? Unless geographically isolated, the work of the ordinary executive is closely intertwined with that of his colleagues. Profit-sharing provides extra compensation based on the profits of the whole company, which are the joint product of the entire management group and which reflect the collective effort of everyone. Although it may be on an individual basis, the usual plan provides for payment based on the work of the entire group. It fully satisfies the test which we set up, that where jobs are interdependent group payment should be provided. If the apportionment is carefully and fairly done, the distribution may be so arranged as to provide, in addition, a fairly strong individual inducement.

Can the method of apportioning the shares be handled so that the division is considered fair? If a concern wishes to adopt existing salaries as the basis of distribution, the participants can be told in advance their percentage of the total fund. This makes for definiteness, but it may diminish the effectiveness of the spur because individual accomplishment is not reflected in the distribution unless the base salary is changed. If certain salaries are out of line, this method

may be considered unfair. But the most serious fault with apportioning management's fund on salaries is that the advance in the latter often fails to keep pace with the increase in the executive's contribution to profits.

To take account of this fact, I have discussed at some length in "Managerial Profit Sharing"* the use of the "salary margin" bonus being paid only on that part of the salary over a fixed sum, such as $2,000. This method provides for major executives bonuses which are larger, both absolutely and relatively. Enough systematic guides are already available so that the chief executive, who should give his personal attention to the distribution, can devote himself to finding a proper method of handling the exceptions. If he, or the department, makes a careful explanation of each of these exceptional cases to the man concerned, dissatisfaction is minimized and the distribution becomes a powerful tool for the improvement of management.

Since the desired goal is to apportion the fund directly on individual performance, the appraisal of each man's results becomes the central problem. This is the point at which future experiment is most needed.

The plans of the Studebaker Corporation and the Leeds and Northrup Company are typical of those which are true managerial profit-sharing on a predetermined basis. They are presented because one company is large and the other is of medium size. In the Leeds and Northrup Company, all of the common stock is owned by the active management, but the profit-sharing arrangement is depended upon for the incentive. In this company, the participating group is about eleven per cent of the number employed.

In contrast to these two plans, that of the Bank of Italy is not confined to managerial profit-sharing because it provides that managers and rank and file shall receive the same percentage of bonus. Participation is neither confined to the management group nor does the latter share on a different basis from the employees.

Now for results. If an executive is told that, in addition to his base salary, he is to receive a share of a fund that bears a definite relation to the net earnings of the business, ways of increasing these profits become part of his thinking both on and off of the job.

Extra compensation based on the earnings of the entire company makes the business *as a whole* the central interest of each executive.

* See Chapter IV of "Managerial Profit-Sharing" (John Wiley & Sons, N. Y.) which is a discussion of improvements in technique.

This not only helps to break down the tendency toward water-tight compartments, but aids in coordinating the work of staff technicians with line executives.

A properly designed plan also tends to accelerate the training of junior executives. When the older members of the group recognize that their share of net profits is increased by developing a strong corps of capable assistants, they take it upon themselves to train them. As these juniors become eligible to participate in the fund, their interest is broadened beyond their own jobs and departments, and becomes active instead of passive.

In the ordinary concern, profits are the only universal unit of measure for the work of major executives. Perhaps the chief importance of using profits lies in the fact that they are an index of ability and willingness to cooperate, both on the part of major and minor executives. Since most managerial jobs are closely interwoven, the success of these executives depends greatly upon the cooperation of others. A premium is placed upon harmonious team work by the use of extra-compensation based on net operating profits.

PRODUCTIVE BONUSES

By KENNETH B. ANDERSON

THE department total of actual productive hours worked on bonus and the average efficiency of direct labor are the two factors which determine the amount of bonus paid to foremen at the Dahlstrom Metallic Door Company.

Assume, for the sake of illustration, that the door-making department averages 1,000 productive hours a week. The rate setting department after a study of past records and present conditions may establish 800 hours as the minimum number that will allow a full bonus payment to the foreman. If too many jobs go through on straight day work, the weekly total may fall short and amount to only 600, in which case only 75 per cent of the foreman's time worked would be used in computing his bonus.

Departments having gang foremen as assistants to the department supervisor have the required number of hours subdivided according to the relative size of each gang, whose leader then receives full bonus only when the hours of the gang are at least equal to its quota.

The first year in which the plan was operating, approximately 60 per cent of all productive hours were on bonus. The average for the first five months of this year shows that the percentage has been increased to 85 per cent. The remaining 15 per cent day work is due to small jobs that do not justify the setting of rates.

In 1927, the total weight of goods shipped was three times the weight recorded in 1919, while a comparison of direct labor hours for the same years shows that the 1927 total is only twice that of 1919. Much of this increase in the productivity of direct labor can be traced to the foreman bonus which has been responsible in no small degree for the effort and loyal cooperation obtained.

Not slow in analyzing his bonus, the foreman soon realized that he was now financially interested in regular attendance, a minimum labor turnover, careful training of new men, fair rates set by the time study department, minimum amount of rejected work, and careful attention to upkeep and repairs.

YARDSTICKS OF PROCESS CONTROL

By F. EDSON WHITE
President, Armour and Company, Chicago

WHILE I was going through one of our plants, a short time ago, the lunch gong rang. In a minute or two the machinery had slowed down and I noticed that each man without exception had turned off his operating light. I mentioned the fact and was told that the budget was largely responsible. To meet the budget which the various foremen had set for themselves, and which had been approved by their superiors, advantage had to be taken of every opportunity, however small. Consequently, the minute the machinery slowed down for the lunch period, each operator turned off his light.

This is an example of how the budget serves as a goal. The various foremen had committed themselves to a definite objective as far as costs were concerned. That objective was set largely at their own initiative, and it was their own goal. They felt they were bound as men of honor and good foremen to achieve what they had promised, or at least to do everything that could be done to reach that goal.

To do this, budgets must come up through the organization, rather than be superimposed from the top. This, in fact, is the way our budgets are prepared. The foremen in our plants and the managers of our sales branches are the men who start the budgets. Many times they make their estimates in consultation with their salesmen or assistants. The budgets are then passed on to their superiors for examination, approval, or revision. They finally work higher and higher through the organization so that the executives can get a picture of what the program is all the way down the line. If the objectives had been imposed wholly from the top, the budget would be in the nature of instructions, or orders, with the implication of coercion. Coming up from lower down in the organization scale, the budget represents a voluntary goal, a cooperative and constructive effort.

Under such conditions the morale of the organization is improved; everyone feels himself to be a part of the organization. The budget helps banish from the minds of employees the idea that the cycle of their activities is from pay-day to pay-day and that there is nothing beyond the task immediately before them.

Our budgets have been in existence for about four years, and they are by no means installed as effectively as we hope they will be ultimately. Our experience, however, has made clear to us that the establishment of budgets is something rather revolutionary in business. It is because of this that we expect it will take considerable time to make the budgets what they should be.

The budgets have established a new standard by which to judge

Research work is one of the fundamental necessities for successful budgeting. Here is a corner in one of the laboratories where food analyses in the chemical division of research are constantly being made

results of particular departments. Formerly, we had various methods of appraising results by departments. We had done some work on the efficiency of our labor, and had taken into account, as much as rule-of-thumb methods permitted, changing conditions, but our chief reliance was on the record of the previous year or the corresponding month of the previous year. The immediate past was our principal guide in appraising the accomplishments of our various departments.

The deficiencies of last year's record as a standard are obvious. An improvement over last year may be due wholly to circumstances for which a particular department should get no credit at all. An improvement may be due to an exceptionally poor record the previous year and does not represent what should have been done.

The establishment of a budget sets up a new standard side by side with last year, and if the budget is correctly prepared it will take precedence over last year as a standard. The crux of the problem is the preparation of a correct budget.

A little experience in the preparation, revision and approval of budgets brought out forcibly that we really did not have the measuring sticks we needed. Our salary budget in the clerical division probably showed an increase, and the explanation showed more work was to be done, but we did not know whether the present force could take on that additional work or not. It was not enough merely to know how much work had to be done; it was also necessary to know how much each person should do and from that determine how many people were needed. Then, further, it was necessary to know what was an adequate compensation for work of that quality and character. If we were to use last year as a guide, we would be using as a standard something which contained all the errors of last year. What we needed was a standard based upon a real analysis of what the output per person should be, what was reasonable compensation for that work, and then by considering the total amount of work to be done, determine what the expense should be for doing that work.

You see, budgets were indirectly the occasion of our doing some real thinking on the standards which were in existence in our company, and standards which should be in existence. The result was that we did some job-analysis work to determine what was being done and what should be done, and then, by comparison with what was paid for similar work in other companies and other businesses, determined how much we should pay per hour for the output we

were getting. The objective, of course, was to raise our standards of what should be done rather than keep up with the past record.

The help we brought in to aid us in establishing these new methods were, in general, men who had been scientifically trained in their particular fields. Their methods were accepted scientific methods and they brought with them new ideas which are being absorbed gradually by our organization. We conducted this research work in our plants through an industrial survey department. With its aid we established new standards which have increased production per man per hour, increased wages, and at the same time cut down unit costs. We did the same thing in our offices through job-analysis under the supervision of our controller and are endeavoring to do the same thing for our sales divisions. We are carrying on sales-analysis work, some market-research work and sales-training research.

The setting of new and higher standards is not sufficient to insure their attainment. It is necessary to show how these standards can be attained. In our personnel division we have a separate department called the training department which puts special emphasis on training of sales help. It is not sufficient simply to determine what a good salesman should sell, but it is also necessary to show how he should sell in order to sell the quota assigned to him. In every large business new men are coming in constantly who must be trained in the company's ways of doing business, trained in the knowledge of the company's products, and trained how to introduce these products so that the public will know their merits.

Recently we established a research division in our business of which the budget department is a part. Research, setting of new and higher standards, and the establishment of definite goals or objectives through the budgets according to our experience, go hand in hand and must be coordinated.

In addition to the research work being done within our organization, we are also carrying on research of conditions outside of the company which may also affect our budgets. The internal research work is conducted with the idea of controlling such activities in a better manner than previously. The external research work is conducted so that we can accommodate our operations to things beyond our control.

The outstanding outside research work we are doing is in the live-

stock supply field. Our volume of operations are not within our control. The packers have made it a rule always to buy what comes to market so that the farmer need never fear being unable to sell his livestock. Our problem is to know in advance what the livestock supplies are likely to be. Take for example the fluctuations in the cattle and hog supply. In the case of cattle this year there is every reason to expect a smaller supply than last year.

It is not reasonable, therefore, to expect our cattle slaughter to be comparable with last year. Circumstances are different. On the other hand, in the case of hogs, supplies are materially larger.

This factor must be allowed for in planning and judging our hog

"With standards established the problem is enforcement of the budget. This cannot be done unless accounting records are compared month by month with budgets"

slaughtering. Therefore, our budgets are practically based on anticipated, not past, experience.

A related problem is to estimate in advance what prices are to be paid for livestock and what prices will be secured from the products resulting from slaughter. It is not generally appreciated by the public that the chief item in the cost of meat products is the price paid to the producer and that the packer takes comparatively little for processing and selling animal products. The big items, therefore, in our financial budget are the number of livestock and the price of livestock we buy. Without the development of research work in both the supply field and the price field, neither our operating budgets nor our financial budgets can be adequately prepared.

All this appears to be cut and dried, mechanical, mere efficiency studies. In order to take care of the human element we have accomplished all this scientific work with contacts, campaigns, and similar devices for arousing the enthusiasm and the spirit of emulation in our organization. Last year was the 60th anniversary of the establishment of Armour and Company. During the year we conducted our 60th Anniversary Sales Campaign. Our whole sales force was organized to win 60th anniversary prizes. We endeavored also to acquaint the public with the fact that we have been serving it for 60 years under all kinds of conditions and circumstances.

The response of the employees to all these influences must be noted, reported, and rewarded, when reward is due. In our personnel department records are kept of each employee in the entire organization. These records have been set up because we realize that in a large business it is possible to be partial to individuals whose work can be observed, whereas others, possibly just as deserving or not so capable of putting themselves forward, are being overlooked. We have, therefore, everything available which is significant regarding our employees. When the time for an advancement arrives, we endeavor to have all men capable of holding the open position so classified that no one is overlooked. Because our employees know this they have an incentive to personal enterprise. This helps to eliminate any feeling that personal likes and dislikes are influential in executives' decisions. We endeavor to choose the man best capable of filling the vacancy.

The budget puts in specific terms what has been planned. Of course, it is impossible to prepare a budget without doing some

Old and new methods of cutting shoulders. Power machines have greatly aided in budgeting the time for specific jobs

thinking and planning. The value of the budget lies largely in this fact. The thinking and planning is done at the time when it will be most productive of gratifying results. A great deal of thinking is done after something has happened which probably could have been done beforehand. This thinking in the preparation of the budget forestalls or eliminates difficulties. A good deal of the analysis of our accounts which shows us that something is seriously wrong should have been done at the time the budgets have been analyzed. When an executive approves a budget, therefore, he commits himself to being satisfied with the accomplishment of his budget, unless conditions prove radically different from expectations. Then the budget would be revised.

Coordinating the efforts of the various departments is of particular concern. It is very essential that our sales division, scattered as it is all over the United States and many other parts of the world, have ideas in line with our production departments. When the budgets come in we are able to discover to what extent there is a disagreement in programs, plans and expectations. With these differences adjusted the machine works smoothly.

When standards have been established, and when provision has been made for the carrying out of these objectives through the adequate training of the personnel, the practical problem remaining is the enforcement of the budget. This cannot be done unless the accounting records are compared month by month with the budgets. Failure to meet a budget should result in a prompt checkup to discover the causes, for it is only by insisting that the budget be met that it can be of any value and retain the respect of the organization.

There is a simple, common-sense way of appraising the merits of a budget. Does it help produce results? As the budget department is not a profit-and-loss department it is not possible to determine exactly what it is worth. In Armour and Company, in fact, the budget department consists of 10 people, who simply compile the budgets and present them to our budget committee. The results of the budgets must be reflected in the results of the various operating departments, and by the same token, the budgets can be no more effective in a business than the operating executives make them. The operating department which will not make use of the budgets will get little benefit from them. As much is realized from budgets as is put in them.

A NOVEL BONUS FOR QUALITY

ELI LILLY AND COMPANY use a plan of paying a bonus for quality, based on complaints received from customers.

The production organization is divided into five groups. Bonus for the first, the raw material group, is based inversely on the number of complaints per hundred thousand pounds of material per month. It is paid to the gang and pro-rated to individual members.

The bonus to the second group, which is responsible for designing and controlling manufacturing operations, formulas and process control, and the third division, in charge of package designs and control, is computed on the same plan.

The fourth group comprises some 63 individuals who inspect each package and see that the correct number and kind of tablets, for instance, are contained in a bottle and that the packages are wrapped and labeled neatly. Each individual in this group receives a quality bonus of $15 per month. For the first mistake chargeable to an individual he or she forfeits one-half this bonus for six months. For the second mistake in six months the whole bonus is forfeited; on the third mistake in this period the individual is discharged as unable to maintain the standard set by the department.

The fifth division containing the individual who is responsible for chemical control of quality receives a bonus, paid every six months, and based equally on the number of outside complaints per hundred thousand pounds of merchandise and on the cost of manufacturing the items produced during the six-month period.

Results have been very satisfactory. Complaints from customers have declined substantially in all divisions.

FAST WORK AND GOOD WORK *PAY* THESE MEN

A BONUS plan, to be a good one, must work both ways. It must advantage both company and employee. And that—to begin at the wrong end of the story—is exactly what management accomplished at The General Tire and Rubber Company of Akron, Ohio, for the extra awards made possible under their four-fold incentive plan not only serve to make employment with the company extremely advantageous, but also permit the company to secure and retain the highest type of tire builder.

In a word, four separate and distinct sources of income are open to every employee—his regular pay, his good workmanship bonus, his attendance bonus and stock dividends. All management asks in return is that he take advantage of the opportunities held out and measure up to certain standards of achievement set by the company.

Why the company considered an incentive plan advisable may demand explanation. And the explanation is simple. In any factory, large or small, somebody has to do the work. Everyone cannot be a foreman, much less a superintendent. Yet all normal workers—especially the sort this company wishes to attract—are ambitious and have the desire to increase their earning power and improve their standing with their fellows. That may smack of truism, but it was recognition of those fundamental facts which led the company to set up the system now in force.

Manufacturing practice at the General factory automatically limits the number of tires that any man may build in a day's time. There's a reason, of course, for such a policy. It guards against defective tires and insures quality workmanship in every tire the company sends out. Not only that, but the limitation of output permits every tire builder to earn the maximum day's pay without hurrying or otherwise jeopardizing the quality of their work or their standing as good workmen.

But there are tire builders who, through long experience or because of superior mental or physical equipment, can build more tires than the slightly slower though equally qualified and reliable man next to them. Naturally it was discouraging at times, despite fair pay and steady work, for the fast worker to feel that he had reached his highest efficiency and highest possible wage. There was also the disquieting knowledge that new men added to the factory force were able to learn tire building in a reasonably short time and show in six months or so earnings as great as his.

It was to reward this type of employee and to insure his continued service, then, that the company set up the AA bonus system which permits him to earn $22.50 a month over and above his regular wage.

The first and most important requirement figuring in the award of AA cards is first grade workmanship—the AA tire builder at the General factory must produce perfect tires. Next come good attendance and punctuality, deportment and care of tools. In addition to the extra pay and recognition enjoyed by the AA card holder, he is assured of steady employment in good times or bad. His job

is protected. Foremen, superintendents and fellow workmen regard him as not only qualified for promotion when openings occur, but also with respect due him as a result of the official recognition which the company has given his employment in the department.

A man must have been in the company's employ upwards of a year before he is eligible for AA standing. Once he receives his card, he retains the AA status indefinitely, or until for some serious reason he is asked to return his card. When a man forfeits his rating, he loses it for at least six months. At the end of that period he regains it for a two weeks' trial and is given an opportunity to demonstrate that his work is once more up to standard. Incidentally, very few men have ever lost their cards, even temporarily. Once a man makes the grade, he is naturally reluctant to give up the extra $22.50 a month and puts forth his best effort to retain his standing.

Quite aside from the advantage of the AA system to the employee is the improved quality which is its most important result. With the plan in operation, foremen and department superintendents believe they have almost positive knowledge that materials have been properly compounded and calendered, that the fabric plies, sidewalls, beads, rubber cushions and treads have been handled and built into the tire with precision and without being damaged in the operation.

So much for the AA bonus system. Bonuses for regular attendance and punctuality are open not alone to the AA men but to every employee of the company, who is present at work every day of a given pay period. He receives, in short, $5 in addition to his regular pay, or $10 a month. The plan, therefore, puts a substantial cash premium on punctual and regular attendance. The tire builder who is absent without a good reason loses his day's pay of $7 plus $5 bonus—a total of $12, which makes him think at least twice before staying away.

Flexible rules—under which the attendance bonus operates—permit workmen to leave their work without sacrificing their bonus. A man who has reported and worked for at least five hours of the day may leave to attend to urgent personal business. The company pays the bonuses in all instances where time is lost through breakdown of machinery or other unavoidable suspension of work. The rules also allow workmen to exchange working time or shifts with other workmen engaged in the same operation and of equal efficiency when illness or other causes require a man to remain at home at night or during the day.

How well the attendance bonus works is proved by the fact that 87 per cent of the company's employees earned it regularly last year and collected more than $100,000 from the company in addition to regular pay.

GIVE THE INDIFFERENT WORKER A SECOND CHANCE

By CLIFTON SLUSSER
Vice-President and Factory Manager, The Goodyear Tire and Rubber Company, Akron, Ohio

WHEN a new man hires in at the Goodyear factory, we train him, direct him, and bring him to his maximum efficiency in the shortest possible time.

If he isn't properly fitted for the job he was hired for, we discover that quickly—at the most within two weeks. Frequently on the first day we let go or transfer to another job a wrongly hired new man.

It is a kindness to the employee, we feel, to find out quickly if he is going to fit into our organization, or if he is never going to progress very far. And, too, it is a matter of necessity for the company. Recently a man was found doing only half a job on his second or third day. When asked why he shirked, he explained that he had hurt his back in a mine accident and couldn't lift very much. This information he had concealed from our doctors and our labor department; in fact he had lied when asked if he were injured in any way or unable to do a man's work. Obviously, a man like that would be an expensive liability for any employer.

Labor training is nothing new; a growing concern always needs to break in new help. Since 1919 we have given the matter more detailed study, making time and motion studies, yet allowing each department to handle labor training in the least troublesome way.

In January, 1927, we set aside a separate labor training department, with a permanent skeleton staff, and began to handle training and re-training in a really big way.

Our labor training department fulfills three distinct functions:

1. It trains new labor.

2. It re-trains old and inefficient labor, or equips men in one department to handle the jobs in another department.

3. It re-locates misfits.

We started, early in 1927, with the theory that "no one is too good for labor training." At its beginning the department looked as if it might be only a heavy expense, particularly as tire-building is somewhat seasonal and there are months in the year when we do not hire.

And yet we knew that a labor training department couldn't hold the interest of competent men unless we made it a permanent proposition.

So we set up a skeleton organization, of which no member could be drafted for other factory work. This organization is elastic, drawing on production foremen as it needs them, and sending these men back into production when not needed. We maintain one instructor for approximately each ten new men, until they acquire proficiency.

The Goodyear Flying Squadron, the famous training school for factory executives, also is drawn upon for instructors. Thus we can expand our labor training staff from its normal strength to a peak force, use these men for a few weeks as trainers, and then send them back to their former positions. Each department understands that when a man is borrowed for labor training, his place must be kept open for him.

Thus we solved the first problem of this department, which was: "How can we create a permanent labor training department without having a lot of expensive and idle teachers standing around for several months of the year?"

In the first few months of 1927 we found out many things about labor training. We had always known that a man transferred from Plant One at Akron to Plant Two, or vice versa, didn't get along so well. Plant Two makes mostly small-sized tires and has special machinery for that purpose, but the products of both plants are fundamentally alike. And yet transfers often caused us nearly as much trouble as new men.

Studying into the existing methods of labor training, we found that departments and foremen had developed certain little kinks of their own. Just enough variation existed between these two plants to make an expert workman in one feel awkward in the other.

Some of these variations and new methods were fine, others were

not. Our first task was to compare all the existing methods of doing each job, and standardize on those which achieved the best results. We put Plants One and Two on a uniform system, so that the work of any man is interchangeable.

We learned also that some men weren't getting any training at all. To cite an extreme example, we found one lad leaning up against a post in the mill room, observing—as he had been doing for two weeks—and waiting for someone to put him to work. Today such a worker is trained and producing in four days.

We give early attention to safety instruction. Page one of the instructor's manual discusses safety methods in detail. The new man's first interview with the foreman in that department emphasizes the necessity of conforming with our safety program. If a new workman is found wilfully violating any safety precaution, he is instantly discharged. This much we insist on.

We soon learned something about the expense of training new men.

Some jobs in our factory can be learned in two or three days. With present day machinery, with the goods cut to fit to the smallest fraction of an inch, with constant inspection and other safeguards, a new man can make tires right from the start, under competent direction. He may only make two tires his first day, but they will be good tires.

Other jobs cost as high as $150 to break in a new man. We watch the turnover in a department like that!

We keep records of the output achieved by each new man, and credit this production against the cost of his instruction. The difference is charged to labor training. Each labor training foreman is interested in keeping his particular costs down, so if a new workman is found unable or unfit to accomplish the task set for him, the labor training foreman wants to find it out quickly. If a new man drags along for two weeks and is then let go, the foreman is asked *why* he hadn't discovered the workman's unfitness sooner. It would have saved the expense of trying to cultivate impossible material.

These figures on the cost of labor training may lead to something new and interesting. If it should cost too much to train new men, perhaps it might be cheaper to borrow money and make a peakload volume of tires during the dull winter months rather than to lay off in the fall and re-hire in the early spring.

The tire business always has been seasonal and still is dependent

to a large extent upon warm weather and a pleasant touring season. All of us would like to smooth out the hills and valleys in our employment curve; and we are making a steady improvement.

When it is necessary to lay off a man, we take his home address and notify him when a job is ready for him again. If he comes back, he gets credit for continuity of service. Goodyear always has placed particular emphasis on having seasoned men.

When January, 1928, rolled around, after one year of our special labor training division, we had an opportunity to see tangible results. From December, 1927, to January, 1928, we stepped up production from 42,000 tires a day to 63,000 tires a day. This remarkable increase was accomplished with a minimum of hardships and interruption to routine. We were able to put the new men to work in record time, and also to gain this increase in production with fewer new men than ever before.

This convinced us, if we needed further proof, that a separate division for labor training is an economy.

But one further advantage we have gained from this labor training division is the handling of temporary surplus labor—a problem easily solved; and the re-training of misfits and incompetents.

Men become misfit, we find, either because they were not properly trained in the first place; or because they have failed to adopt changes which have gradually crept into the product; or they may have become physically unfit or have slipped into careless habits; or better methods than those taught them may have been developed.

Our labor training foreman, skilled in determining whether a man is handling his work properly or not, can quickly diagnose any man's failings. Also, our production foremen are urged to discover those men who are not really happy in their jobs and turn them over to us for re-training.

In our tire rooms alone in 1927, where we had a total average payroll of 1,200, we re-trained 251 men and turned them back to production, on their old jobs. These men showed an average efficiency gain of 15.6 per cent! Many men we have re-trained show a gain in efficiency as high as 40 per cent.

In re-training a man, it first of all is necessary to gain his confidence. If he thinks he is merely being speeded up he will not cooperate. We spend ample time in explanation, showing each man where he is falling down. Very often a time study of his present methods will reveal one or two details in which he is at fault, and

when these errors are pointed out to him, he corrects them. We have had many instances where the work of re-training has been done almost entirely by the man himself, and willingly.

Other cases have arisen where men were doing work for which they were absolutely unfitted, either by build or intelligence, and these have been given second chances to see if we could not, somewhere among our 19,000 Akron workers, find places for them.

Our first year of labor training brought to light some cases which had dragged along for years. We found 37 men on our payroll who were hopeless for any job.

One of these men was a floor sweeper. He was nearly blind in one eye and had defective vision in the other. We fixed up a financial plan for this man, whereby he received 30 weeks' pay in cash, and then introduced him to the best eye doctor in town. This doctor was able to remove the cataract from the good eye and to give back half vision to the eye that had been nearly blind. This workman is back on his job now, efficient and happy.

Another extreme example of a misfit was found also among our sweepers. This man was a college man who had been on the payroll for 12 years and who had drifted down from one job to another until he struck bottom. He was hopeless. We let him go.

So, one by one, we went over the case of each of these 37 men, trying to find what each was fitted for and only discarding them after every other effort proved futile. Most of them, we found, never should have been on the Goodyear payroll at all.

Our plan prevents such a thing now. If a man never is going to gain much success in a job, it is a kindness to him to discover that fact quickly. Better to steer him into something more congenial than to carry him along for years and then find he is no good.

Goodyear has always prided itself on being a young organization, and yet at the same time we value the loyalty of our older workers.

This year we will give vacations to 46 per cent of our factory men. This will cost us $350,000, in addition to the bother involved in filling places for a week or more. A five-year man receives one week's vacation with pay; a 10-year man gets two weeks with pay.

We have aimed at a permanence, a continuity of employment, at Goodyear. We value our freedom from labor disputes. We value the feeling that inspires a young man starting at the bottom to settle down in his humble task, satisfied that the company is going to look out for him if he does the right thing. The loyalty of seasoned,

faithful men has much more than a dollars and cents value. Some of our best processes were suggested by men long on our payroll. We *want* 10-year and 15-year men.

We assume that a "new" men holds his maximum efficiency up to five years, and make no special allowance for length of service. But to a five-year man we allow a 5 per cent leeway in production; that is, he can produce 5 per cent less than the average and still qualify for the job. A 10-year man gets a 10 per cent leeway, meaning that he can turn out 10 per cent less than a new man and still hold his own as far as our records go. A 15-year man or older gets special consideration.

Thus we aim to deal with our factory men humanly and individually. No man gets discharged except for cause, and even then if it is possible to salvage him and use him somewhere else, we do it.

Fitness or unfitness, we find, is not necessarily a matter of age. Men slow down because they're self-satisfied or lazy, or possibly they do less than they might because of discontent. Perhaps no one really explained the job to them in the right way. We find it worth while to tell each workman as much as he wants to know about what he is doing and why, and how his work dovetails into the work of other departments.

For 30 years we have operated on a policy of friendliness between factory men and officials. My own office is operated on the open-door policy. Any man in overalls who has an idea or a grievance is free at any time to take it up with headquarters. All of us know hundreds of men in the factory by their first names.

And yet, of course, we are not running a playground or a happy home. We are here to make tires that will sell and can be sold at a profit. We are in a strongly competitive field. Every dollar of expense must justify itself.

So, in selecting new men to continue the Goodyear organization into the future, we examine them for fitness and aptitude, and make sure they are right for the job. If a man lacks either mental or physical fitness, if he can't or won't learn, we learn it quickly.

If a new worker stays on the Goodyear payroll for more than two weeks, we tacitly promise to look out for him. We'll provide growth and opportunity for him as he is ready for it. Making sure that each man is getting the most out of his job is a secondary task for our labor training department. And yet in maintaining plant loyalty and enthusiasm, who can count its benefits?

In operation, we find—in its second year—that our labor training division already can get along with fewer men. The accumulation has been cleaned up. Our instructors are trained now and can cover more territory. Each labor training foreman covers a certain number of departments, working closely with the problems of those departments at all times. When it is necessary to expand suddenly and take on new men, he is prepared.

We find, after nearly two years, that we are saving money by having our own labor training division. It puts new men to work sooner. It saves expensive days in education. It standardizes training methods, making our work more uniform and our product better. It enables us to increase our output with less hardship.

And in addition we count the second but important advantage that we can now give a second chance to the man who isn't getting anywhere at his present job. This, we feel, is an advantage to which industry has given too little thought. At Goodyear we want "old" men, and we want them productive and settled and happy.

MAINTENANCE HALVES THE REPAIR BILL

By L. LEIGHTON FARRAR
Industrial Engineer

THE greatest waste from repair work in industry today is not in the cost of a repair but in the loss of productive time that each repair entails. It is a case of "penny wise, pound foolish," if great technical knowledge and planning skill are utilized to cut down the cost of repair rather than to eliminate the repair itself.

In the majority of industrial plants today a separate repair department is maintained, with its own machine tools, located in a specified section of the plant. Here the repairmen have their lockers and work benches, and they report directly to this department either to finish work left from the previous day or to await new repair requisitions, sent in by the foremen of the departments in which the breakdowns occur. This method of handling repairs, it is true, does get the work done in the shortest possible time.

A study of repair jobs and their causes, however, will reveal the fact that the great majority are almost entirely preventable. Lubrication, for instance, or rather lack of lubrication, causes more equipment failures than most of the other causes combined. A

group of machinists, asked what percentage of repair work they thought was preventable, gave answers ranging from 50 per cent to 90 per cent. The writer, working with these men, would be inclined to favor the higher percentage.

Maintenance, as applied in this paper, refers to factory machinery, and only to that portion under the control of the repairman. This restriction is important, because there are factors in repair work over which the mechanic has not, and should not have, any control.

A good example of this kind is found in the speeds and feeds of machines. In endeavoring to increase the productivity of a certain factory department, the management increased both the speeds and feeds of the machines beyond their capacity. The result was that for over three weeks half of the 20 machines affected were under constant repair by at least two machinists, who finally solved the problem by designing a special safety-pin arrangement that could be quickly and cheaply replaced.

It is hardly to be expected that a repairman would be held responsible for the failure of the machines involved in such a situation. With this distinction in mind, a few typical repair jobs and their causes will be reviewed. They are in no way exceptional, but illustrate very clearly the need for maintenance rather than repair.

The first example is that of a large Bliss press that had just been erected. The management had decided to run it in before putting it on production work, the process to take about three hours. Due to someone's negligence, the machine was run without oiling, with the result that the main bearings were burned out, and the crankshaft had to be returned to the Bliss factory for machining. Considerable discussion and shifting of responsibility followed, but because no one department or man was responsible for the maintenance, it was impossible for the management to penalize the guilty party. Obviously the failure was due to faulty management, as no great technical skill is required to lubricate a press.

The second example is a fine illustration of the growing importance of maintenance in straight-line production, where the breakdown of one or two machines can shut down whole departments, and in some cases, whole plants. In the case in question, two Columbia drills had been installed for use in machining connecting rods, and had broken down. Connecting rods are drop-forged, but the hole for the wrist-pin must later be drilled. The Columbia machine is a continuous, rotary drill, carrying six fixtures, with two

drills apiece, in which the pieces are inserted by the worker and drilled in one rotation of the machine. A cam feeds the drill and withdraws it after one rotation, when the piece may be extracted.

When the repairman arrived on the job he found that one of the main oil holes to the spindle had become clogged, with the result that the spindle had become heated and fused with the bearing material, tying up the whole machine, as the damaged spindle would have destroyed the cam if the machine had been put into operation. The other drill was also broken, so that the entire department was idle until the repair job was completed. This took two days. The rest of the plant was kept in operation by drawing on a large reserve stock of connecting rods. This method of safeguarding production by the maintenance of large inventories is extremely expensive.

Another frequent source of repair jobs which are entirely preventable is that of wilful neglect and ignorant destruction. An example of this was observed in the case of a small punch press in a sheet metal department. The press knocked badly, and the operator was told to report it to the repair department, as the main bearings required rebabbitting. His answer is typical of the attitude of unskilled and ignorant workers toward the machines under their care. He said that he didn't care what happened to the machine as long as he made production and received his bonus.

Within a few days the bearings failed and the teeth on the pinion gear and eight on the large driven gear were stripped off. Instead of a simple rebabbitting job requiring a few hours, there was the additional task of making a new pinion gear and building up the eight stripped teeth on the main driven gear. This required three days.

The question may well be asked, "If such large percentage of repair work can be eliminated, why has it not been done?" Only one answer presents itself, and it is that under usual systems the interests of management and labor are directly opposed. The mechanic is hired to repair broken machinery; for him to try to reduce the number or frequency of breakdowns would be to work himself out of a job. Instead of attempting to cut down the number of jobs or the time lost in repairing them, the repairman by systematic soldiering and wasted effort manages to account for his nine hours daily. This condition exists because the management requires the men to keep busy the entire day. The ideal condition would be for the men to be idle the whole nine hours because the factory was operating in a condition of 100 per cent efficiency.

The first essential of a good maintenance plan is that it shall combine the interests of the worker and the management. This essential constitutes the basis of the following proposed plan. Co-operation can be secured simply by allotting to each workman a definite section of the plant, and making him responsible for keeping it in running condition. It is then to his interest to prevent breakdowns, because it means less work and more pay for him if he does. He is no longer haunted by the fear of losing his job if repair work becomes scarce, but he may lose it if it does not.

A plan of this kind worked well in a certain small three-story plant. Prior to the change of system the three men in the repair shop could not keep pace with the work, despite the fact that they sometimes worked during lunch hours and Sundays. Finally, a dispute arose and the foreman was accused of favoritism in handing out jobs. To correct this condition, the plant was divided and each man was given one floor and its machines to maintain. Three weeks after the change the frequency of breakdowns was reduced to one-third its former volume and the time lost in repair was reduced to 20 per cent of its former value.

Under an arrangement like this, the first thing the repairman should do is to make the acquaintance of the foremen and men in his section. He will then be in a better position to instruct the men in the proper use and care of their machines. Ordinarily it is up to the foreman to acquaint each new man with his job and machine, but the trouble with this method is that the foremen could usually profit by a few instructions themselves.

The problem of lubrication, for instance, is a game of hide-and-seek in which the worker usually loses. Machine designers seem to think that the best type of lubricating device is one that is hard to find. One repairman was able to reduce the frequency of failures by painting the oil holes and grease cup distinguishing colors so that the operator could easily locate them.

When a machine is "laid up" the worker knows to whom to report it and just where to find him. No requisitions need be made out or red tape waded through to get the repairman on the job. Each machine will have its individual lost-time card, on which the mechanics fill in the repair and cause, while the operator records the lost time. An advantage of this double entry is that while the repair mechanics would like to put down as little time as possible, the operator wants to record as much as possible especially if he

is working on a piece-rate. This opposition of interest will result in a more honest and accurate time report than is usual under the old system.

Another advantage of the individual machine card is that the repairman can note any repetition of causes and in a measure anticipate and correct them. Previously he had no way of analyzing or comparing one repair with another, as he might never work on the same machine twice. Many accidents, moreover, may be prevented if the operator can get in touch with the repairman and call his attention to a machine that is "acting funny," or a bearing that is overheating.

The reason why the percentage of time lost for actual repairs decreased faster than the percentage of repair jobs, in the plant cited above, can be easily explained. Under the old system, the mechanic is sometimes sent to repair a machine whose like he has never seen before, and must learn the machine before he can attempt to repair it. Under the new plan, the repairman soon becomes familiar with the different types in his department and expert in their maintenance. He knows their peculiarities, where they give trouble, how often, and just the procedure to follow in making a repair.

In the process of actual repair, another factor enters. To complete a repair the mechanic must often make a jig to facilitate the work, particularly if the machine is heavy. On one job it required two hours to make the jig, and only one to complete the repair, but without the jig the job would probably have required seven hours. Under the former system, the workman would discard the jig because the chances would be strongly against his ever working on that particular machine again. But given a definite group of machines to maintain, he will save every device that will make his work easier, and in this manner reduce the actual repair time considerably.

In the department to which he is assigned, the mechanic should work in cooperation with the foreman, rather than under him, for two reasons. In the first place, he will do better work if he is his own boss; and secondly, he should be able to instruct the foreman as to the proper use of his machines, and should have the authority to shut down a machine to make a necessary repair.

This latter power should be limited, and the mechanic required to consult with his repair foreman if the repair would require more than a limited time. This time would, of course, vary in different departments and in different plants. The foreman of the depart-

ment could consult the superintendent if he thought the delay unnecessary or likely to interfere too much with an important production schedule.

The remuneration of the mechanic should be based entirely on his efficiency, measured by the reduction of the time lost in repairs. Before the system is installed and the men given definite sections to maintain, a careful analysis of the repair reports should be made and the amount of lost time for each department determined and used in the following formula.

The percentage of lost times to total times is used rather than actual lost time, because a discrepancy creeps in if the total time is later increased by the addition of a new machine to the department.

$$\text{Earnings} = H_a R_h + \frac{X-Y}{X} H_a R_h \qquad \text{or}$$

$$\text{Earnings} = \text{Time wages} + \text{Time wages} \times \frac{X-Y}{X}$$

$$= H_a R_h \left(1 + \frac{X-Y}{X}\right)$$

$$= H_a R_h \frac{2X-Y}{X}$$

where X = Standard per cent of lost machine time to total machine time

$$= \frac{\text{Old lost machine time}}{\text{Total machine time}}$$

where Y = Actual per cent of lost machine time to total machine time

$$= \frac{\text{New lost machine time}}{\text{New total machine hours}}$$

R_h = Rate per hour

H_a = Hours actually worked

To illustrate:

Total hours (old) . . . . = 1,000
Total lost time (old) . . = 300
New lost time . . . . . = 150

$$\text{Using actual times} - \text{fraction} = \frac{300-150}{300} = 50\%$$

$$\text{Using percentages} - \text{fraction} = \frac{30\% - 15\%}{30\%} = 50\%$$

Now suppose a new machine is added to the department increasing the total hours to 1,100. If the lost time is increased to 165 the workman should receive no reduction in pay because the percentage of lost time is still 15 per cent of the actual total department hours. But if we use actual lost time the workers suffer as shown

$$\frac{300-165}{300} = 45\%$$

If we use the percentage method, it will automatically adjust itself

$$30 - \frac{165}{\frac{1100}{30}} = \frac{30-15}{30} = 50\%$$

By examining the formula it is found that the best that the worker can do is to double his base rate, for if he entirely eliminates repair work "Y" becomes zero and the fraction

$$\frac{X-Y}{X} = 1 \text{ and we have } 2\,R_h.$$

This brings us to the consideration of the base rate, which will vary in different sections of the country. In Detroit, the rate for repairmen is approximately 80 cents an hour for a 50-hour week. The worker will want to be certain of an increase in his wages before he will attempt to increase his efforts on behalf of the company. In the lost time analysis probably at least 10 per cent was wasted by the workman applying ordinary attention and skill to his work. This should be used as a penalty factor, making the base rate $0.72. In actual practice the fraction will vary from 30 to 80 per cent, giving an hourly wage of between $0.98 and $1.26.

PAYING EXECUTIVES FOR RESULTS

By M. E. LEEDS

THE Leeds and Northrup Company has used some form of simple bonus arrangement with its executives since its early history. Changes during the wartime period made a readjustment advisable and the present plan provides for the creation of a bonus fund into which go half the profits of the company for the year, after the preferred stock dividend and a 6 per cent common stock dividend have been provided for.

This fund is distributed to executives, who participate on a sliding scale according to their power to influence profits by their decisions. For example, a foreman in the lowest group, getting a salary of $2,000, would have a share proportioned to 1,000, which a man in the upper group getting a salary of $10,000 would share on the basis of a 60,000 proportion.

M. E. Leeds, president, in presenting his paper before the American Management Association, justifies this basis of division on the grounds that participation in profits, above wages, should be based on the degree of participation in management.

The company reserves the right to make payments either in cash or in stock; if one shares in the fruits of an undertaking he must be content to take his share in whatever form it is available.

Discussion by other executives of the plans used by their companies brought out a general agreement on principle in payment of executives, and an emphasis on plans which base participation on savings made by the executive over a predetermined standard of performance.

THE MANIT SYSTEM IN OPERATION

By F. W. CORLEY
Vice President and General Manager, Con. P. Curran Printing Company

WE INVESTIGATED many plans for improving methods, realizing that progress comes only by keeping in constant touch with all possibilities. Finally, in February, 1926, we decided to adopt the "Manit" idea of the Haynes Corporation.

Briefly, the "Manit" is a standard man-minute of work. It applies regardless of the conditions under which any work is performed. Thus, the number of Manits per hour establishes a definitely comparable rate for totally different types of work.

Those familiar with the diversity of jobs which pass through the composing room of a print shop, for instance, will readily sense the difficulties of comparing the work of different compositors, one perhaps operating a lintoype machine, another a monotype, a third hand-setting solid text, and a fourth setting only headlines.

Through a combination of time study and analysis of each particular job, it was possible for the engineers to determine the maximum each worker could do under normal conditions, with reason-

Monotype work is one of the production operations done under the Manit system

able concentration and without producing undue fatigue likely to injure the quality of the work or impair the health of the worker.

This was accomplished by an engineering study of elementary operations entering into type composition. In some industries the work is so highly repetitive that the jobs recur with all their elements in regular sequence, but in our business the elements of any one job, as compared with any previous or subsequent one, may differ, not only in number, but in sequence and in the time required.

Let us take as an example our hand composing department. The work was classified into a number of general operations, which were again divided into all of their proper elements, and proper time allowances established for each and every one of these elements. This material was catalogued in such a manner that it became possible for one, even though not thoroughly experienced in hand composition work, to be able to set accurate and fair Manit standards on this class of work through the use of these tables and classifications.

	OPERATION	MANITS PER	MANIT STANDARDS — SIZE OF BOTTLE IN OUNCES														
			½	1	2	3	4	5	6	8	10	12	14	16	18	20	24	32
1	Get pill bottles from stock and place on bench	100 Bottles	**2.7**	**2.9**	*3.4*	*3.9*	*4.4*	**4.6**	*4.9*	*5.1*	*5.4*	*5.6*	*5.9*	**6.1**	*6.4*	*6.6*	**7.0**	**8.0**
2	Transfer bottles from truck to bench	"	**1.3**	*1.4*	*1.5*	*1.6*	**1.7**	*1.8*	*1.9*	*2.1*	**2.3**	*2.6*	*2.8*	*3.0*	*3.3*	**3.5**	*4.0*	*4.9*
3	Fill bottles with coated pills	"	*9.5*	**9.6**	*9.7*	*10.3*	*10.8*	**11.3**	*11.8*	*12.8*	*13.8*	*14.9*	*15.9*	*18.9*	**17.9**	*19.2*	*21.3*	*25.6*
4	Fill bottles with plain pills	"	**12.0**	*12.2*	*12.4*	*12.8*	**13.5**	*13.8*	*14.3*	*15.4*	*16.1*	*17.2*	*17.9*	*18.7*	*19.5*	**20.2**	*22.4*	*25.6*
5	Weigh pills or tablets	"	**9.1**	*10.2*	*12.2*	*14.0*	*15.7*	**17.0**	*18.3*	*20.2*	*22.2*	*23.2*	*24.2*	**25.2**	*26.2*	*27.1*	**29.2**	*33.2*
6	Pack cotton in bottles	"	**2.9**	*3.3*	*3.9*	*4.5*	*5.0*	**5.4**	*5.8*	*6.4*	*6.7*	*7.0*	*7.2*	**7.4**	*7.6*	*7.8*	*8.0*	*8.4*
7	Pack and hammer-in cork	"	**3.2**	*3.2*	*3.1*	*3.1*	**3.1**	*3.1*	*3.1*	*3.2*	*3.2*	**3.3**	*3.3*	*3.3*	*3.3*	*3.3*	*3.5*	**3.8**
8	Wash exterior of bottles	"	**7.8**	*7.9*	*8.0*	*8.2*	*8.3*	**8.4**	*8.5*	*8.7*	**9.0**	*9.3*	*9.6*	*9.8*	*10.0*	*10.3*	**10.7**	*11.4*
9	Apply Towel to bottles	"	*5.3*	*5.4*	**5.5**	*5.6*	*5.7*	*5.9*	*6.0*	**6.2**	*6.5*	*6.8*	*7.0*	**7.3**	*7.6*	*7.8*	*8.2*	**8.8**
10	Label by hand {bottles, cartons, packers}	100 {bottles, cartons, packers}	*14.1*	**14.8**	**16.6**	*17.8*	*19.8*	*21.1*	**22.2**	*23.7*	*24.9*	*26.3*	*27.3*	**28.1**	*28.1*	*28.1*	*28.1*	**28.1**
11	Paste cork stickers	100 Bottles	—	—	—	—	—	—	—	—	**4.5**	*4.5*	*4.5*	*4.5*	**4.5**	*4.5*	*4.5*	**4.5**
12	Paste size stickers	"	—	—	—	—	—	—	—	—	**8.2**	*8.2*	*8.2*	**8.2**	*8.2*	*8.2*	*8.2*	**8.2**
13	Wrap with parchment	"	—	—	**32.4**	*35.0*	*37.5*	*38.8*	*39.3*	**41.2**	*42.5*	*44.3*	*45.0*	*45.5*	*47.5*	**50.0**	*55.2*	*57.8*
14	Remove strings after parchment wrapping	"	—	—	*2.7*	*2.7*	**2.7**	*2.7*	*2.7*	*2.7*	**2.7**	*2.7*	*2.7*	*2.7*	*2.7*	**2.7**	*2.7*	*2.7*
15	Transfer finished bottles from bench to truck loose	"	**0.9**	*1.0*	*1.2*	*1.3*	**1.5**	*1.6*	**1.8**	*2.1*	*2.4*	*2.8*	*3.1*	**3.4**	*3.7*	*3.9*	*4.2*	**4.9**
16	Set up cartons	"	**6.0**	*6.0*	**6.0**	—	—	—	—	—	—	—	—	—	—	—	—	—
17	Label cartons	100 Cartons	**17.6**	*18.5*	*20.8*	*22.2*	**24.8**	*26.4*	*27.8*	**29.6**	*31.1*	*32.9*	*34.1*	**35.1**	*35.1*	*35.1*	*35.1*	**35.1**
18	Pack bottles in cartons	100 Bottles	**5.2**	**5.2**	**5.2**	—	—	—	—	—	—	—	—	—	—	—	—	—
19	Label packers	100 Packers	**12.0**	*12.6*	*14.1*	*15.1*	*16.8*	**17.9**	*18.8*	*20.1*	**21.2**	*22.3*	*23.2*	*23.9*	*23.9*	**23.9**	*23.9*	**23.9**
20	Paste contents label on packer	100 "	*8.2*	*8.2*	*8.2*	**8.2**	*8.2*	*8.2*	*8.2*	*8.2*	**8.2**	*8.2*	*8.2*	**8.2**	*8.2*	*8.2*	*8.2*	**8.2**

			TAPE LENGTH IN INCHES														
			6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
21	Tape manilla packers (all around)	100 Packers	**5.4**	*7.0*	*8.2*	*9.6*	**10.9**	*12.3*	*13.3*	*14.5*	**15.8**	*17.3*	*18.7*	*19.9*	*21.0*	**22.5**	*24.5*	*24.5*

			TAPE LENGTH IN INCHES							
			22	23	24	25	26	27	28	29	30
21	Tape manilla packers all around continued	100 Packers	*26.5*	*26.5*	*28.8*	*28.8*	*30.0*	*30.0*	*31.5*	*31.5*	*31.5*

Note: *Numbers in* **BOLD** *represent time-studied standards*
Numbers in ITALICS *represent interpolated standards*

DR 50

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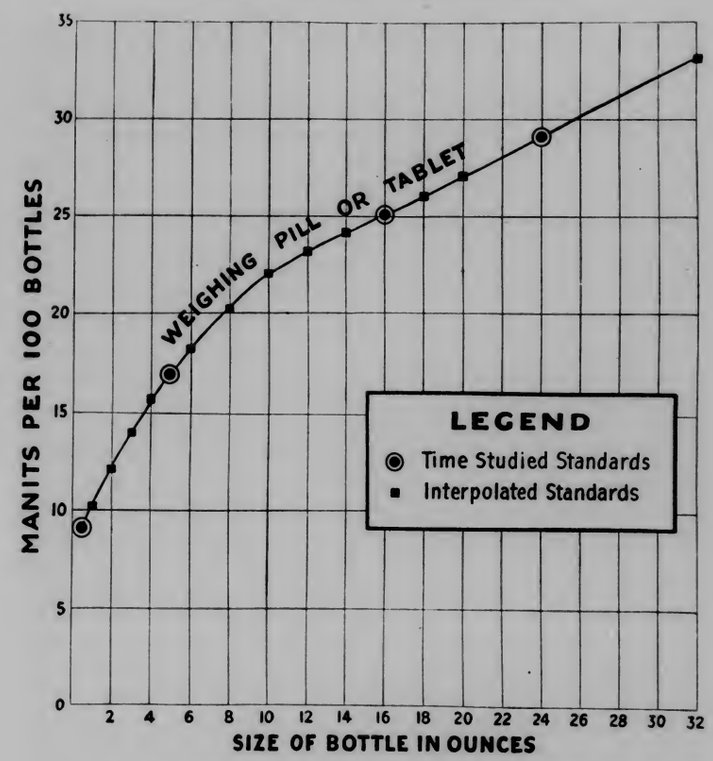
Manit standards are made up in table form

THE task of establishing standards for a wide range of individual operations is greatly simplified by an interpolation diagram, based on the principle that differences in standards follow a definite mathematical formula.

Time studies are made on three or four widely separated differences in the nature of an operation, the standards for which are plotted as points on a chart, and thereby establish the curve, on which intermediate positions are interpolated.

The accompanying table of Manit standards was developed for the filling and finishing department of a large drug manufacturing company, and illustrates how standards may be determined from a comparatively small number of time-studies. In this table 20 distinct operations are shown, each with individual differences based on the size of bottle (in ounces) involved. One operation is shown, that of taping manilla packers, in which the variation is due to the length of tape, in inches. In both these tables the time-studied standards are shown in bold face type; the interpolated standards in italics.

To illustrate the plan by which the interpolations are made, Operation 5—that of weighing pills or tablets—is presented in the Manit graph on the opposite page. In this chart the time-studied standards are shown in circles, while the interpolated standards are shown as black squares. The time-studied standards definitely establish the curve. All of the remaining standards are in the path of this curve, from which they are interpolated. The chart demonstrates that only four variations in the operations were time-studied, but standards for 12 additional variations were developed analytically



Graph of Manit standards for Operation 5 (from table)

With both day workers and piece workers under the Manit system, there is a very real incentive to each to approach as closely as possible the true maximum day's work, since all that each produces above the standard Manit rating of 60 Manits per hour *adds* to his pay proportionately. All employees, including supervision and service labor, are financially interested in the results.

The savings to the company come from the raising of the average production from the 30, 40, or 50 Manits per hour that may be found to exist prior to the installation of the system to the standard

of 60. The increased earnings of the workers come from the range between 60 Manits, which they *should* produce and the 75 Manits or more which they *can* produce without impairment of the quality of production, and without excessive strain or fatigue. Hence, each employee working below 60 Manits per hour has the opportunity to increase his pay 25 per cent when he reaches the full day's work of 75 Manits per hour.

Incentives to supervisors and to incidental and service workers are also paid proportionately to the increase in Manits per hour of the productive workers whom they direct or serve. A fixed proportion is set aside for that purpose, and each such employee participates according to the relative importance of his work in furthering greater production efficiency.

It should be explained that the reduction of "waiting time" is also a factor entering into the bonus paid to supervisors and to indirect or service labor. Thus all factors entering into labor efficiency and economy are controlled through equitable standards and budgets.

So much for the mechanics of the plan. What about its reception by the management and the men in our organization? Of course, like anything else that is the least bit different, some potential objection was present because of normal mental inertia. Our observation and experience is that in any management plan the executives have to be sold before going ahead; having been thus sold, they must push the matter to the end. A following of this procedure led us through the various stages without any marked difficulties.

Of course at the outset we had some objections from employees, but these were chiefly from old employees and were to be expected. These people had been on the job for ten or fifteen years and thought they were sufficiently qualified as experts to warrant them in saying "Nobody can tell me how to do it." The attitude, more often unexpressed than otherwise, was "We can't produce any more than we are now producing. We ought to know. We have been at it for such and such a number of years."

Just to show that this point of view was unsound let me cite a case. Before we started with the plan under discussion, a trimming operation by experienced employees showed a rating equivalent to 52 Manits. Under our present plan of wage incentive this job shows an average of a little more than 70. Once, in fact, it ran up to 90,

but this we admit was in the nature of a spurt and we didn't expect or wish it to keep up.

Of course you have to have a sound fundamental incentive plan to start with and one that is eminently fair; in addition, if you would minimize the difficulties in its installation, you should have an installation engineer whose personality is a decided asset. We were very fortunate in this respect, and attribute to this fact our relatively small amount of difficulty with the employees. We assigned one of our own men to work with him at all times, an arrangement that worked very well indeed.

Perhaps I am getting a little bit ahead of my story, for before selling the bulk of the employees on the new plan we put our efforts into enlisting the support of the supervisory staff—the general superintendent and heads of departments. It wasn't that they had any objections to the idea, but at the very first they lacked the necessary enthusiasm for it—that enthusiasm that must be behind the effort toward every worthy object.

And when we came to selling the bulk of the employees the problem was essentially the same as with the supervisory force. It was lack of positive enthusiasm rather than negative objection that constituted whatever problem we had. There was the same old mental inertia. Old habits of thinking had to be broken down and new ones built up, but almost before we knew it they had become partially sold and soon they were 100 per cent for it.

With most of the employees the problem soon resolved itself into a simple task of telling them all about the plan in such a way that they could readily understand it. This was not difficult, and once done, the rest was relatively easy. In other words, it had all the elements of a true selling job.

Word-of-mouth evidence, we found, was a great help in speeding up the selling idea to the employees. As soon as the advantages of the plan became apparent to an employee who held the confidence of his fellows, the rest quickly came to the same conclusions.

We, in the management, never became discouraged, or even near it. Every new outcropping of problems was in the nature of a new challenge to our ability as managers. It kept us keyed up to our duties and our opportunities.

Our employees now approve of the Manit system fully, the only complaints being concerned with occasional mistakes in rating.

Those that make the Manit rating of 60 per hour are not hard worked.

This wage incentive plan shows up very conclusively what many executives have often observed, that those workers making fast motions are not necessarily the fast workers. On the other hand, the *apparently* slow worker may rate high. He makes only those motions that count for something.

Boiled down, and from the point of view of the employee, the Manit system practically guarantees certainty of work for those that "make the grade." People are not subject to frequent layoff, and their "jobs" become "positions." From this angle, besides the reduction in unit costs the management gains from reducing labor turnover practically to zero.

While it has no particular bearing on the Manit installation, the following experience seems to me interesting from a managerial standpoint. After our present wage incentive system had been in operation for about 1½ years we decided that while large gains had been made, still greater advancement was ahead of us if we could cut our individual labor—in other words, through better supervision.

So, in view of years of experience, we made the best estimates we could of what might be accomplished in this direction now that we could enlist the full cooperation of everybody. In January, 1928, we took from our records an average 8-week period in each department. We also took the average volume of those 8 weeks and found our average unit labor costs.

In each department the accumulative savings since January of last year have been considerably *in excess* of the predetermined savings set up as a goal to strive for.

The program was laid before the various department heads, both in the form of letters to them and through individual conversations —not by group conferences.

Altogether, the results of our wage incentive plan has been most gratifying from the standpoint of both company and employees. Most industries in America realize that low production cost and high wages are, in effect, synonymous. Both are concurrently possible under well organized methods that place incentives not only before management but also before workers. Plans which are fair to both sides remove the friction from plant operation.

REGULATION OF FACTORY OVERHEAD

By H. G. PERKINS
Industrial Engineer, The Murray Corporation of America

THE American public is so accustomed to stupendous accomplishments that it views the spectacular march of progress of American industry during the past quarter century with a calloused lack of interest and unappreciative eye. This apathy is the more surprising when it is realized the present day public enjoys many more things, by reason of the reduced cost of output resulting from this progress, than would have been within their reach 25 years ago. If we permit ourselves a thoughtful and thorough period of retrospection on some of the phases of this industrial transformation, we must be struck with the fact that we have not only lived to see a period of brilliant mechanical development, but have observed also an equally remarkable trend in management methods.

Not the least of the present-day developments are the managerial weapons that are becoming more prevalently used to widen the gap between cost and selling price. Remarkable as the accomplishments by means of these weapons have been, the significant phase of the present situation is the fact that the end has not yet arrived, because the managerial intellect of American industry in general has only recently applied its genius to this problem on a scientific basis, and because as yet there does not exist a universal and thorough appreciation of the possibilities still before us.

No one will claim that the management methods industry will use 50 years hence can be accurately forecasted, and none will dispute the fact they will be quite different from the present standard and so much superior as to make the present appear by contrast as crude as now seem the standards of 50 years ago. If this evolution is to come eventually, cannot its arrival be hastened many years by more concentrated application of our best minds to this matter immediately? The author lays no claim to be living in advance of his age and he is not a seer whose forecasting eye can foresee the future industrial picture. He realizes this article is, in fact, a case of the blind leading the blind, and it is written with the one hope that it may stir some originative mind to the creation of the next progressive step in the scientific economization of those expenditures necessary to the operation of industry.

This step will include not only the creation of new methods but

the wider and more efficient use of those of the present day. Consideration of these current devices and their application may have the effect of stimulating thought on the possibility of refinements and additions to present practice with the result that new ideas will be conceived which will mark the next milestone in the progress of scientific management. Without attempting to classify them in the order of their importance some brief comment will be devoted to the various agencies that may be called upon to assist in the control or reduction of items of general expense or "overhead."

Discipline. At one time discipline was the major factor in keeping expenses down. It still has an influence, although other elements have proved far more effective for the purpose than a "call down" after the money has been spent. However, it is not difficult to conceive the disastrous results which must follow in an organization that does not feel the weight of the management's displeasure when excessive or unwarranted expenditures have been made. The moral effect of discipline must not be discounted. It might be said that discipline is of a negative value because it employs punishment for past shortcomings; but its influence on future actions is not to be underestimated. The spanked child does not immediately repeat an offense. We may therefore say that discipline is entitled to some measure of consideration in the control of overhead.

Education. Another weapon of somewhat different character, whose importance is often not fully appreciated, is education. Too often management has been inclined to exercise discipline, when as a matter of fact the fault lay at the management's door because responsibility given to an individual was not accompanied by instructions which would make that individual fully realize his duties, or the possibilities within his grasp. It is an actual fact in the author's experience that a surprising number of shop foremen do not know the price of lubricating oil per gallon, or the value of the perishable tools used in their departments.

Management could do nothing more effective to control overhead than to educate its supervisory class to the proper interpretation of material things in terms of the dollar. The man who spends his company's money in actual purchase of incoming materials clearly visualizes the extent to which he obligates the company. Is there less reason for a clear picture in the minds of those who consume these things? Educational work along this line is certainly an essential part of any well-rounded procedure on the control of overhead.

Research. Of somewhat similar vein is the matter of research. Tireless study and investigation will often reveal possibilities of further reduction of expenditure seemingly at an economic minimum. The author has seen many economies effected merely because of refusal to accept the current condition as being the last word, despite its apparent soundness. A persistent challenge of these apparently acceptable expenditures sometimes reveals surprising results in the way of substitution or elimination.

As a case in point, the author knows of an instance where the substitution of crepe paper for cloth used to protect automobile interiors during assembly has resulted in a saving amounting to thousands of dollars. The surprising thing is that the experiment was not thought of years before its actual introduction. It may be stated as an uncontradicted fact that the control of overhead is incomplete if study and research are not in constant use.

Incentives. Another of the very important—if properly handled—means of reducing overhead is through the medium of well-regulated incentives to those responsible for results. One form of incentive which has come within the notice of all of us is the expectancy on the part of the executive of promotion in due time. When he accomplishes something a little out of the ordinary, or when he spends a considerable amount of his own personal time on the job—more than he is expected to do—or when by extra effort or unusual ingenuity he accomplishes an especially noteworthy result for the company, whether he is an executive or a layman, he is subconsciously thinking of promotion. This form of recognition is expected by all of us as we become more valuable to our employers through the acquiring of experience and knowledge of the particular work with which we are entrusted.

We have all seen the man of mediocre ability suddenly become transformed into a veritable dynamo of energy and endurance, solely because of a promotion, which though perhaps well deserved, was a little unexpected. It cannot be overlooked that the likelihood of promotion exerts a very great influence upon the will to accomplish and the desire to make a showing in some particular field. However, in order that promotion may be depended upon as a means of keeping executives on their toes, there should be recognized procedure, a well-established and well-understood cycle of cause and effect, with cases in point from time to time judiciously brought to the attention of fellow-workers in a way that keeps them believ-

ing in the justice of the management with respect to this form of recognition for faithful and loyal service.

Another form of recognition which is seldom given credit for its real value as a means toward reducing manufacturing expense is the recognition of an employee by words of praise publicly given, or by suitable titles judiciously bestowed, or by giving an individual a certain responsibility which places him in the limelight among his fellow-workers and makes it a matter of pride for him to bring his individual accomplishment to the highest point.

Still another form of incentive which never fails to produce results when fairly and justly applied is a bonus to responsible executives. One outstanding criticism of bonuses of this kind, as operated in many cases, is the fact that the bonus has not necessarily been given to those most deserving of it. As it is often worked out, the individual who could put up the best appearance before his superior, or who managed to get public recognition for some of his accomplishments, was the individual to receive the lion's share of any bonus money that was being distributed. An executive bonus, to be successful, must recognize ability and accomplishments only. That the individual be a personal friend or favorite of his superior, or that he succeed in advertising his accomplishments, must not be a pre-requisite to receiving a bonus. The bonus plan must be worked out on an equitable basis, arranged to reward most those whose responsibilities for results have been greatest.

The purpose of an executive bonus is, of course, to arouse keener interest in the financial success of the enterprise, and to induce each individual to do all in his power in his particular sphere of activity to increase profits. Inasmuch as the amount of net profits is tangible evidence of the effectiveness of the endeavors of executives and supervisors, it would seem that the net profits should be the basic element of the executive-bonus plan, and that the amount of the bonus shall bear some relation to the volume of net profits.

Therefore, as a first consideration in the payment of an executive bonus, the profits available for a bonus after satisfying dividend requirements, proposed increases in fixed assets, required increases in working capital, and reserves for contingencies, should be ascertained. In the event there are profits available for bonus, a base bonus of percentages of annual salaries varying with the individual's classification may be paid for a range of net profits from the minimum at which it is considered proper for the company to pay bonus, up to a probable maximum.

Having determined the base bonus rate for each of these classes of executives, the management should arrange to make adjustments for individual performances. These adjustments will be modifications of the base bonus, either up or down, depending upon the performance of the individual in relation to certain fixed standards which are set for determining the efficiency of the activities under his supervision. These standards include three main items, namely, direct labor, the expense of indirect labor, and the use of maintenance materials and supplies. These figures may be obtained through budget-control routine, and require no computation over and above that ordinarily made for budget determination.

Each of these factors in any department should be given a weight in relation to the other factors so that the totals in every case amount to 100. For instance, in a sheet-metal pressroom, direct labor might be given a weight of 60, productive labor a weight of 33, and supplies and maintenance expense a weight of 7, the total of these weights equalling 100. Then an efficiency rating for each factor may be determined by dividing the standard or budget figures for each expense item by the actual expense for the period. The result is then multiplied by the weight of that factor, as just given, to get the adjusted weights as the resulting over-all efficiency of operation for the responsible executive. It is needless to say that the amount paid the executive in bonus is quite negligible when compared to the savings effected, when reasonable intelligence is used in the application of the bonus.

There are many who will disagree with this procedure and there are many who will take sharp exception to the views just expressed. The comment made here is inserted merely for the purpose of stimulating thought on this important subject. Many other forms of incentives can be applied to executives and those in responsible positions to accomplish the results of increased economy of operation. The three common incentives just discussed, namely, promotion, personal recognition, and bonus, are merely examples of the more prominent expedients that may be adopted to bring latent and dormant energy to the surface and convert it into company profits.

It is becoming more and more the practice, especially in the higher competitive manufacturing industries, to recognize the effect of ups and downs in production volume on the expense of operation.

It is, of course, well known that during periods of curtailed output it is always advisable and sometimes necessary to retain a skeleton organization which at such times does not work at high efficiency. It is also common knowledge that as production increases, expense also increases, but at a slower rate, so that unit expense costs at high production are usually less than at low production rates.

For example, the unit cost of operating the factory accounting department in one automobile plant was $24 per car when the output was 4,000 cars per month; $19 per car with an output of 6,000 cars; $15 per car with an output of 8,000; $12 per car with an output of 10,000; $10 per car with an output of 12,000; and about $8.50 per car with an output of 14,000.

Not only in internal affairs, but also in those affecting vendors and distributors of product, the standardization of output plays an important part. The author will not be contradicted when he says that the greatest influence on standardization in costs is standardization of rate of output. Full appreciation of the significance and importance of operating on an even keel is vital. No production program can be considered completely planned until the effect on costs has been estimated. This procedure will sometimes result in shop production rates either greater or less than the current rate of demand, especially in the production of individual parts or assemblies. Increase in the inventory of finished parts is sometimes warranted if it creates a float or bank that at a later date obviates the necessity for operating at either peak or low rate.

Efforts to standardize costs through standardization of rate of output should not stop with the planning of shop activities. Since the fluctuation of factory output is controlled primarily by conditions in the retail field, dealer organizations may rightfully be asked to assume their equitable part in relieving the uncomfortable pressure borne by the factory during periods when the rate of output is over or under normal. The dealer naturally wishes to keep his stock of unsold products at a minimum in order to get the best turnover on his invested capital; but the dealer has a duty to the factory that sometimes necessitates carrying stock in excess of current minimum requirements.

The policy of operating a factory in strict conformity with the current retail demand not only affects the cost of output, but the quality as well, and this is a matter of as much concern to the dealer

as to the manufacturer. Furthermore, if a manufacturer equips his factory for an output that will satisfy the peak demand of the dealer, he is confronted with the problem of idle machinery throughout the greater portion of the year. The only solution to this problem is to keep the rate of output from the factory as nearly uniform as possible and to take up some of this irregularity in dealer stocks.

One of the most active as well as one of the most powerful means of controlling expense is a properly designed and vigorously operated budget-control system. The comparatively recent interest in budgetary control as a specific tool of management has come about as a supplement to other developments and improvements in the science of management. Many refinements and improvements are yet to be made while it is settling into its proper niche in the repertory of the modern industrial manager.

It may be well to call attention at this point to the fact that mere installation of budgetary-control procedure will not in itself regulate expenditures. Budgetary control is simply a means to an end. It is a tool of the industrial manager's trade, and like other tools it must be designed for the work at hand in the light of past experience. It must be cared for and guided with a skilful hand if it is to serve its purpose. In the operation of budgetary control procedure it is necessary that many contacts be made between the department operating the budget and those in the organization responsible for actual results. Very much depends upon the nature of these contacts with respect to the results which may be expected from them. It is probably unnecessary to say that the relationship of those operating the budget to those responsible for obtaining results in the factory should be that of the counsellor, the guide, the helpful team-mate.

Dictatorial policies in the budget-control department are usually met with resentment, ridicule, and finally with contemptuous disregard. Cooperation can be realized best when those responsible for expenditures are allowed a voice in the determination of their budget. Such cooperation usually results in budget quotas that are at once sufficiently reasonable to command respect and encourage thrift, and at the same time sufficiently rigid to stimulate vigilance on the part of the executive and prompt him to challenge every item of outlay with the question "Is this absolutely necessary?" Without such challenge, the budget may encourage waste.

The mere setting of budget quotas does not in any way replace the necessity for strict, intelligent, and vigorous enforcement of means for the realization of these quotas so far as is practically possible. Usually the type of man at the head of a department who would be called upon to submit proposed budget figures for his department would also be one from whom intelligent judgment on such matters might be rightfully expected. Furthermore, he is in a position to know the detail of the operation of his department and therefore understands reasons which may not be apparent to the budget department for deviations from results which might seem in all fairness to be rightfully expected.

The placing of attainable budget quotas before executives as guides in the operation of their departments, and as measuring sticks for results which they are expected to accomplish, constitutes one of the biggest steps towards enforcement and accomplishment of budget quotas. This is to be followed by the issuance of reports which supply the department head with sufficient detail data to enable him to make an active and intensive study of his subordinates. Accurate and prompt reports and information showing the relation between actual accomplishments and budget quotas are an essential part of any budget procedure which has as its purpose the systematic regulation of operating expenses.

When all has been said and done about the various measures that may be employed in the regulation of expense, the subject may then be diverted to consideration of the one element that has a greater influence on results than all others combined—the human element. Even the finest and most scientific procedure will not operate automatically, and is useless from the standpoint of practical results secured, if the organization itself has neither the ability nor the inclination to support it.

No procedure or system is a substitute for the ingenuity or will-to-do of man. Determination, experience, intelligence, and enthusiasm have a greater bearing on economical and efficient operation than the finest budget system. It is true that the weapons mentioned above will have a great influence in stimulating these qualities, but they are effective only when the inspiration of a dynamic management and the support of a capable organization are conspicuously behind the budget, so that it becomes an actual working tool instead of a pious hope.

THE POINT SYSTEM OF WAGE PAYMENT

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THE point system is more than an incentive plan of wage payment in that it forms a means of analyzing and controlling the cost, efficiency and compensation of direct and indirect labor in the factory and office.

The point is a unit of measure of human effort, consisting of a certain amount of useful work plus time allowances for rest and delays, the total equaling one minute. The amount of useful work in a point is based upon the performance of an average operator working without incentive at a preconceived ideal standard maintainable speed at which he will produce 60 points per hour. It is understood that the relative amount of work, rest and delay in a point will vary with the nature of the work. That is, for work requiring heavy physical exertion a greater allowance will be made for rest than for work requiring little effort. The total will in all cases, however, be equal to one minute of time (at a 60-point hour).

A point standard is the number of points allowed for the performance of a given amount of work. This standard is set by time study and the worker is guaranteed that the standard will not be changed unless there is a change in the method of performing the operation.

Since there is a point standard for each operation in the factory, the operator knows at the end of the day how efficient he has been The term "productive point hour" is used to indicate the efficiency of an operator on direct labor, and it is the average number of points produced per hour.

For example, assume that a girl is working on a small drill press and she finishes 200 pieces in an 8-hour day, being allowed two rest periods of 8 minutes each. Suppose the point standard for drilling the casting is three points per piece, then the point hour for this operator is:

$$\text{Point Hr.} = \frac{(\text{Good Pcs. Finished}) \times (\text{Point Std.}) + \text{Allowances}}{\text{Number of Hours worked}}$$

$$= \frac{(200 \times 3) + 2 \times 8}{8} = \frac{616}{8} = 77$$

This means that the operator has done 77 minutes work per hour or worked at a 77-point hour.

PREMIUM POSTING SHEET

DEPARTMENT *Motor Assembly* WEEK ENDING *July 28 1929*

		MONDAY							SATURDAY					
NUMBER	NAME	HOURS	POINTS	PREMIUM		PT. HR.	HOUR	HR.	HOURS	POINTS	PREMIUM		PT. HR.	
93274	John M. Simms	8¾	615		.68	70			4½	310		.30	69	
87213	H.S. Wilson	8¾	709	1	.38	81			4½	380		.83	85	
76322	R. Stone													
13520	S. G. Linn													
12633	Bob Smith													
15462	R.R. Meyer													
18621	J. Thomas													
10177	[illegible]													
9653	S.K. Phelps													

The premium posting sheet is posted in the department. It tells each workman his point hour and his premium for the previous day. A new sheet is started each week

Since the operator is producing above the standard of 60 points per hour she is given a premium based upon the premium points that she has produced during the day. The premium points are the points produced in excess of 60 per hour. In the above case the premium points per hour are $(77 - 60) = 17$. For the day the premium points are $(8 \times 17) = 136$. The premium earned by the operator is based on three-quarters of the premium points. Therefore, if the base rate of the operator is 35 cents per hour then her premium is:

$$\frac{136}{60} \times .75 \times .35 = .595 \text{ (use .60)}.$$

The base earnings for 8 hours at 35 cents per hour are \$2.80. The total earnings for the day are then the base earnings plus the premium, or $\$2.80 + .60 = \$3.40$. Since the operator is guaranteed a day rate, in the above case the minimum wage that she can earn for the day is \$2.80 and, of course, the amount earned above this minimum will depend directly upon the output of the operator.

If the operator is performing work for which point standards have not been set or on work for which present standards do not apply, then the work is turned in at 60 points per hour regardless of the amount of work done. This is called "production at 60."

Allowances are delays in production beyond the control of direct labor. In some cases the department is held responsible while in other cases the cause is beyond the control of the department. In either event, the direct labor is not held responsible. All delays are

reported on the daily premium card in minutes. The time allowed is added to the points produced during the day, as illustrated above in the case where 16 minutes were added for the rest periods.

Delays are also divided into two classes: lost time for which the department is responsible, such as machine hold-ups, waiting for work or material, and lost time for which the department is not responsible, including such delays as rest periods, fire drill, lunch (on trick work) and "early quitting" of women employees.

Stop-watch time study is usually the most convenient and most satisfactory method of setting point standards. The methods em-

REG. NO. AND NAME *93274 John M. Simms* DATE *July 23, 1929*

START	FIN.	HRS.	OPER. NO.	DESCRIPTION	QUANTITY	STD.	POINTS	BASE	P
7:45	10:15	2½	2432-A	FORM SWITCH ARM	125	1.3	162		
10:45	3:00	3¾	136-D	DRILL LEVER BODY	90	2.9	261		
3:00	5:30	2½	1246-R	DRILL "D" LEVER	35	5.5	192		
1	2	3	4	5	6	7	8		

TOTAL HOURS	8¾	BASE AMOUNT	5.25	
TOTAL POINTS	615	PREMIUM	.68	CHECKED BY
POINT HOUR	70	TOTAL EARNINGS	5.93	APPROVED BY

A premium and time card is made out daily for each productive operator, regardless of the number of different jobs he performs

ployed are similar to those used by most industrial concerns with the exception that considerable attention is given to rating the operator being timed. It was stated previously in the definition of a point that it was based on the amount of work done in one minute by an average operator working without incentive and that this rate would be called a 60-point hour. It is evident that in timing new operations it will be almost impossible to find an operator working at just a 60-point hour. It becomes necessary, therefore, for the time-study observer to have the average 60-point-hour speed

well fixed in his mind in order that he may be able to rate other operators using this average operator as his measuring stick.

If, for example, a new drilling operation is to be timed and the time-study observer rates the particular operator at a 65-point hour he is indicating that his operator is working faster than the average and that in order to set uniform point standards it is necessary to use this factor to get the standard back to the 60-point hour basis. Suppose the base time selected from stop-watch data is 1.24 minutes per piece. If the operator was working at a 60-point hour the point standard for the drilling operation would be 1.24 points per piece. But the operator was working at a rate of 65 points per hour. Since the speed is above average (60) some allowance must be made for rest and delay. Suppose this allowance to be 3 per cent, then the rating of 65 will have 3 per cent added to it and the rating with rest and delay will be 67. This, then is the correction factor to be used in order to get the base time of 1.24 minutes into standard points. The point standard for the drilling operation will be

$$\left(1.24 \times \frac{67}{60}\right) = 1.38 \text{ points.}$$

Other methods of leveling or compensating for operators above or below the average have been used successfully but the one explained above seems to be extensively used in plants where the point system is in operation.

A checker is maintained in each department or building to see that the operators are turning in their work on the proper operation number, that the count is correct, that the new work is turned in on "production at 60" (equivalent to straight time) until point standards can be set up, and so on. Also the checker makes out the daily premium cards. The checker is directly under the superintendent in charge of the point system and is not responsible to the production foreman in the department.

The illustration shows a common type of daily premium and time card which is made out by the checker in the department. He enters the information in columns No. 1, 2, 3, 4, 5, 6 (the inspection department in some cases necessarily fills in column 6). The cards are sent at the end of the day to the cost department which fills in all other information and calculates the premium and total earnings for the operator.

The premium card summarizes all of the work done by the operator in one day. John M. Simms did three jobs on July 23 as the premium card shows. The first job "form switch arm" has a standard time of 1.3 points per piece. Simms did 125 pieces in 2½ hours. The points earned for this job are 162, or ($125 \times 1.3 = 162$). For the day the points earned on all three jobs are 615. The time actually worked is 8¾ hours. The operator's point is:

$$\frac{615}{8\tfrac{3}{4} \times 60} \times 60 = 70.25 \text{ (use 70).}$$

The operator's base rate is 60 cents per hour, or a cent per minute. He works 8¾ hours, so his base earnings for the day are $60 \times 8\tfrac{3}{4} = \$5.25$.

Premium is:

Points made = 615
Minutes worked = 525
Premium points = 90

$$\text{Premium} = 90 \times \frac{.60}{60} \times \tfrac{3}{4} = \$0.68$$

(Same as 75 per cent Halsey plan.)

Total earnings for day:

$$5.25 + .68 = \$5.93$$

A premium posting sheet giving the operator's point hour (efficiency), his premium earned and the total number of points produced for the day previous, is posted in the department for the benefit of the direct labor working there. The illustration on page 228 shows this posting sheet. The arrangement is such that the operator can tell at a glance just what he earned the previous day and if there is any misunderstanding it can be settled at once. There is also a valuable psychological advantage in posting the efficiencies (point hours) of all the workmen in a department as it stimulates a spirit of competition among the men.

It is possible, in most cases, to place non-productive or indirect labor on a standard in such a manner that the men will be prorated according to the productive work done in the department and they will participate in the premium. The foreman, for example, will receive a premium based upon the point hour of his department. If the departmental point hour is 80 for the week and the foreman receives $1.10 base rate per hour and works 48 hours per week,

then his base earnings will be $1.10 × 48 or $52.80. It is customary in most plants employing the point system to give all indirect labor the full premium (or the same as 100 per cent Halsey plan). The premium then will be computed as follows: (48 × 80 = 3840 points at an 80-point hour); (48 × 60 = 2880 at a 60-point hour); 3840 — 2880 = 960 indirect premium points: premium earned is

$$\frac{096}{09} \times 1.10 = \$17.60$$

Total earnings for the week will be $52.80 plus $17.60 or $70.40.

It is apparent that the more the direct labor earns the more the indirect labor will earn and it should be so arranged that the harder the indirect labor works the more the direct labor can produce and in turn the greater their earnings will be.

It is a relatively simple matter to place productive operations on time standards, using either piece rate or some form of incentive wage. But in most cases non-productive labor cannot be given definite tasks as can productive labor and thus it is difficult to give wage incentives to this class of labor. It, therefore, may become necessary to base the bonus or incentive, if one is to be given to the non-productive workers, on the output of the productive operators of that department. If, for example, one helper in the assembly department supplies material and takes away the assembled units for fifteen men, then to a certain extent the output of these fifteen productive men is dependent upon the services of the helper.

If under standard conditions it requires just one helper for fifteen men on this assembly work, then, the more work these men do (in the same ratio) the more work the helper will have to do. So it would be fair and logical to give the helper a bonus based on the output of the direct or productive labor of the department. In a similar way, the foremen, supervisors, repairmen, janitors and other non-productive labor could be rewarded for their increased effort.

The question immediately arises as to the method of determining the ratio of productive workers that should be served by each non-productive man. There is only one accurate way to settle this question, and that is to make a time study of the work done by the helper. This study would usually last a whole day or perhaps several days and at the same time the helper is being studied all the other non-productive workers in the department would be studied also, as far as possible.

The superintendent of the department and the time-study observer would try to select a time for making the study when the conditions in the department are about normal or standard. That is, when there is an average amount of productive and non-productive work being done. This is desirable because the time studies that are made on these one or two days must be taken as representative for the week or month. After the studies are made it is then possible to analyze them and determine the standard ratios of direct labor to indirect labor for the department.

The standard ratio will be in the nature of the number of points of direct labor to one of indirect labor. For example, the standard indirect labor ratio of 15 to 1 for "helper" in the department would indicate that one minute of a helper's time would be required for each fifteen points of productive work done. Similar ratios could be determined for the other indirect labor in the department and then the actual conditions compared from day to day with these standard ratios.

The indirect wages would be affected by the variations from the standard ratios. If the department is able to operate satisfactorily on less indirect labor than the standard ratio calls for, then this will act to increase the premium for the indirect labor in the department and vice versa. This idea can be extended to practically all forms of indirect labor including supervision.

ADVANTAGES AND LIMITATIONS OF THE POINT SYSTEM

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THE setting of standards for wage payment under the point system was described in the preceding article. It remains to be shown how it is possible to use the data necessary for computing wages under the plan, as the basis for an effective over-all analysis of labor costs and operating efficiency.

The analysis sheet (Figure 1) used for this summary is shown on pages 236 and 237. It contains, in the case illustrated, some 50 columns, which present the various significant elements in the picture of labor efficiency. In this analysis the more significant figure is found in column 12, the point hour—72 points in the example illus-

trated. This means that the average performance of all the productive workmen for August 14 was 72, as compared with a normal or standard of 60. The figure is obtained by adding the actual points credited to the force, deducting for allowances, "production at 60" and so on, and dividing by the equivalent number of hours worked. The latter figure is obtained by totaling the hours worked on productive labor and subtracting allowances for lost time, "production at 60" and the like.

We next compute the department point hour (column 15), which provides an index of the speed of the department and includes everything except allowances for which the department is not responsible and is equal to (column 14) divided by the direct hours (column 4) minus the "lost time department not responsible" points

$$\left(\frac{60}{\text{col. } 14}\right)$$

This gives a point hour of 71.4 or 71. The supporting details of lost time are taken from columns 39 to 52 inclusive.

Column 23 gives us our next control figure, the total ratio of direct points to one indirect point. It is computed as the sum of columns 16 to 22, divided into column 11. It gives a check on indirect labor, by comparison with the standard indirect ratios, the use of which was explained in the previous article.

Net total indirect cost in dollars (column 30) is the next important figure in the analysis. It equals the sum of columns 26 and 29, and includes any excess of actual over allowed costs. Directly following this item is the series of comparisons of cost per 1,000 points given in columns 31 to 37. The usefulness of these comparative figures is apparent.

We next obtain the supervision point hour (column 38), which equals the departmental point hour (column 15) times the ratio of standard to actual cost. This final figure gives a total measure of both efficiency and cost of direct and indirect labor for the period (a day or week), and is used as a basis for determining the premium for all indirect labor and supervision for the department.

A form which supports this analysis is the analysis of "non-productive ratios and standard costs," which is produced on page 239 (Figure 2). Information shown on this form is taken from the indirect labor time studies.

It is sometimes desirable to divide all non-productive work into classes, such as: supervision, clerical, handling, maintenance, set-up,

inspection, and janitor. For example, the foreman of the department may find it necessary for the greatest efficiency to spend the majority of his time on supervision, with some time devoted to clerical work and some to inspection. So also the janitor may spend part of his time on janitor work, some on maintenance and some on handling.

The table is divided into seven vertical columns with headings for each of these seven non-productive classifications. The information obtained from the time study of indirect labor is analyzed and placed in the proper column of the table. For example, the foreman, Wm. Jones, worked at an 82-point hour for 250 minutes (that means that he did 342 points of work) on supervision during the day, at a base rate of $0.80 per hour. In a similar manner the remainder of the non-productive data is noted on the table. Then all of the vertical columns are added and the weighted base rate is found for each non-productive classification.

The total productive points for the day of October 16 were 12,278. The total non-productive points for supervision for that day were 562; therefore, the "supervision ratio" is equal to the productive (direct labor) points divided by the non-productive (supervision) points, or $12{,}278 \div 562 = 21.84$ (use 22). This ratio means that for every 22 direct labor points produced there will be required one minute (point) of supervision. In a similar way the standard ratios are determined for the other non-productive classes. The total non-productive ratio for the whole department is found by dividing the total productive points by the total non-productive points, or $12{,}278 \div 3{,}444 = 3.565$ (use 3.6), meaning that for each 3.6 productive points worked in the department there will be required one non-productive point.

Referring to the second chart, if the supervision ratio is 22, then the reciprocal of this is .047205, meaning that for each productive point worked .047205 supervision non-productive points will be required. If the average base rate per hour for supervision work is $0.762, then the cost per minute would be

$$0.47205 \times \frac{.762}{60} = \$0.0005994$$

In a similar manner the cost can be found for all of the non-productive classes and the total of these is equal to $0.0028379 for

the non-productive labor. (Since the janitor work is placed on a budget this is not included.)

The standard productive labor cost per direct point may be found by dividing the total hours worked by the total direct labor payroll, and reducing this quantity to costs per direct point by dividing by 60. In this case it was $0.007303, or $7.303 per 1,000

DEPARTMENT NO. 23 — ANALYSIS

DATE	EQUIVALENT NUMBER OF EMPLOYEES: ON DIRECT OPERATIONS	EQUIVALENT NUMBER OF EMPLOYEES: ON INDIRECT OPERATIONS	ACTUAL TIME IN HOURS: ON DIRECT OPERATIONS	ACTUAL TIME IN HOURS: ON INDIRECT OPERATIONS	TOTAL HOURS	DIRECT POINTS PRODUCED: OPERATORS ON STANDARD	DIRECT POINTS PRODUCED: OPERATORS NOT ON STANDARD AT 60 PTS P HR	DIRECT POINTS PRODUCED: TOTAL DIRECT POINTS	DIRECT POINTS PRODUCED: DEDUCT FOR SCRAPPED WORK	DIRECT POINTS PRODUCED: NET TOTAL POINTS	OPERATORS POINT HOUR
AUG. 14	23.2	6.98	185.5	55.75	241.25	13182	103	13285	26	13159	72
1	2	3	4	5	6	7	8	9	10	11	12

DATE	TOTAL PAYROLL: FOR DIRECT LABOR	TOTAL PAYROLL: FOR INDIRECT LABOR	JANITOR BUDGET: POINTS USED (472)	JANITOR BUDGET: AMOUNT ALLOWED IN DOLLARS	JANITOR BUDGET: EXCESS	NET TOTAL INDIRECT COST	COST PER 1000 POINTS: ACTUAL COST PER 1000 DIRECT POINTS	COST PER 1000 POINTS: STANDARD COST PER 1000 DIRECT POINTS	COST PER 1000 POINTS: ACTUAL COST OF INDIRECT PER 1000 DIRECT PTS.	COST PER 1000 POINTS: STD COST OF INDIRECT PER 1000 DIRECT PTS	COST PER 1000 POINTS: TOTAL ACTUAL COST PER 1000 DIRECT PTS.
AUG. 14	97.92	32.96	465	3.72	—	32.96	7.44	7.30	2.50	2.84	9.94
24	25	26	27	28	29	30	31	32	33	34	35

FIGURE 1. *This cost summary provides a useful and condensed*

points. Therefore, the total cost per 1,000 direct points will be the sum of the non-productive labor cost and the direct labor cost per 1,000 direct points, or $10.1409.

The non-productive labor cost is one of the factors in a department over which a foreman has complete control. He is responsible for getting the production out for his department and he uses a certain amount of non-productive labor to aid him. The standard ratios give the exact amount that has been allowed him. If he can in any way reduce the amount of non-productive labor used, he will be able to lower his non-productive payroll and show an efficiency in this respect of over 100 per cent for his department. On the other hand, if he uses more non-productive labor than the ratios call for, his indirect payroll will be higher than the standard and his efficiency will be lower than 100 per cent. In either case the exact cause of this variation from the standard will be shown. A

complete picture of the situation for the department is given on the department analysis sheet.

The point plan of wage payment contains very few original features and it is not by any means a complete "system of control," for in most cases it deals with labor only. There is little originality or value in using such terms as "point," "B," or "productive minute."

SHEET

ALLOWED TIME IN POINTS: LOST TIME DEPT. RESPONSIBLE	ALLOWED TIME IN POINTS: LOST TIME DEPT. NOT RESPONSIBLE	DEPT. POINT HOUR	INDIRECT WORK IN MINUTES: SUPERVISION 24	CLERICAL 17	HANDLING 12	MAINTENANCE 20	SET-UP 28	INSPECTION 28	JANITOR	TOTAL RATIO 38
40	43	71	550-2A	712-19	1055-12	200-66	450-29	380-35	—	3349-39
13	14	15	16(16a)	17	18	19	20	21	22	23

TOTAL STD COST PER 1000 DIRECT PTS	RATIO STANDARD COST TO ACTUAL COST	SUPERVISION POINT HOUR	ALLOWANCES - DEPT. RESPONSIBLE: MACH. BREAKDOWN OR TROUBLE	WAIT FOR WORK	TRANSFER FROM ONE JOB TO ANOTHER	MATERIAL TROUBLE	POWER STEAM WATER OFF			ALLOWANCES - DEPT. NOT RESPONSIBLE: REST PERIOD	FIRE DRILL	HOSPITAL	COMPENSATES VOTING ETC	POWER STEAM WATER OFF (OUT OF DEPT)		
10.14	1.02	72	25	15								18		25		
36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52

summary of actual labor costs, in comparison with point standards.

Hundreds of manufacturers are dealing with the same thing by setting standard times and they use the common term "standard minute" and base their operators' efficiencies on 100 per cent as the standard.

The point plan, however, has come into wide use within the last few years and it is used so successfully in many of our industries today that it deserves considerable study and thought. The system is not a ready-made set of forms, methods or rules, but combines many of the basic principles of management. For this reason it can be adapted to fit practically any set of conditions.

The features which make the point plan work out so well in practice and which bring about such large savings to management might be summarized as follows.

1. The point plan provides an incentive for direct labor:

(a) Guarantees a day rate; (b) operators are rated and the

standard is set on the basis of an average operator; (c) proper allowances are made for rest and delay; (d) normal time and "process allowances" are introduced to make the plan more accurate; (e) posting sheets are used to inform the operator just what his point hour (efficiency) was for the previous day, as well as his bonus if he earned one; (f) guarantees are made not to cut the standards unless there is a change in the method; (g) the plan determines the daily "point hour" (efficiency) of each workman which makes it possible for the employees in different departments or plants to compare their standings. This feature is of value from a psychological point of view.

2. The point plan provides an incentive for indirect labor:

The basis for this incentive is an over-all figure which combines the efficiencies of the direct labor in the department (column 12 in Figure 1), and the ratio of standard costs per point to actual costs per point (column 36). This gives an incentive to all indirect labor to maintain a high output and at the same time to keep the actual cost in the department as low as possible.

3. The point plan shows by means of the analysis sheet the conditions in the department and gives one figure (the supervision point hour), which is an over-all index of the general efficiency of the department. This supervision point hour is useful in making comparisons from week to week and in comparing one department or one factory with another.

On the other hand, against these advantages we must offset certain inherent limitations of the plan.

1. Cost:

(a) The cost of installing the point plan is likely to be rather large, since time studies are necessary, and then, after all (or practically all) direct labor is on the incentive plan, a complete non-productive study must be made and the cost ratios determined. (b) If there is a very great change in the methods, or in the arrangement of the work, or if there is a considerable increase or decrease in output, it is very often necessary to make new non-productive studies and determine new ratios. This, of course, is costly. (c) It is necessary to have in each department departmental checkers who supervise the collection of the data for making out the posting sheets and analysis sheets, and so on. The usual time clerk takes care of the routine, but supervision is required. (d)

From a glance at the posting sheet and the departmental analysis sheet it is evident that considerable clerical work is required to handle all of these records, computations and postings. Payroll calculations are also expensive items under this plan.

2. In installing the point plan little or no thought is usually given to the improvement of methods when the original time studies are made. It is generally conceded that a large part of the value of a time study is in the improvement that is made in method or equipment, and if this is slighted a just criticism can be made.

3. As with many incentive plans of wage payment, more rigid inspection is required and there is a tendency for the quality of the

NON-PRODUCTIVE RATIOS AND STANDARD COSTS

DEPT. NO. 23	Supervision @60	Supervision Rate	Clerical @60	Clerical Rate	Handling @60	Handling Rate	Maintenance @60	Maintenance Rate	Set-Up @60	Set-Up Rate	Inspection @60	Inspection Rate	Janitor @60	Janitor Rate
Wm. Jones	342	.80	225	.80							57	.80		
H. J. Thomas	220	.70	79	70							206	70		
J. S. Story					466	.50							87	.50
Wm. S. Black					448	.50							60	50
R. S. Miller					63	.48	106	.48					325	48
A. A. Williams			368	.59							179	.55		
Robert Clark			62	.60			143	.60	406	.60				
Productive Cards									38	55				
	562	.762	734	.615	1013	.499	249	.550	444	6.01	442	.653	472	.486

Supervision $\frac{12278}{562} = 21.84$ - Use 22 $\quad \frac{1}{21.84} = .047205 \times \frac{.762}{60} = .0005994$

Clerical $\frac{12278}{734} = 16.73$ - Use 17 $\quad = .059772 \times \frac{.615}{60} = .0006126$

Handling $\frac{12278}{1013} = 12.12$ - Use 12 $\quad = .082508 \times \frac{.499}{60} = .0006861$

Maintenance $\frac{12278}{249} = 49.305$ - Use 49 $\quad = .020281 \times \frac{.550}{60} = .0001859$

Set-Up $\frac{12278}{444} = 27.65$ - Use 28 $\quad = .036160 \times \frac{.601}{60} = .0003621$

Inspection $\frac{12278}{442} = 27.77$ - Use 28 $\quad = .036010 \times \frac{.653}{60} = .0003918$

Total Ratio $= \frac{12278}{3444} = 3.565$ - Use 3.6

Janitor Budget

472 Min. (points) at .486

Std. cost allowed $= \frac{472}{60} \times .486 = \$3.82$

.0028379 Total Non-Productive cost per direct point

.0073030 Total Productive cost per direct point

.0101409

$2.84 Std. Indirect Labor Cost per 1000 Direct Points
$7.30 " Direct " " " " " "
$10.14 Total Std. Direct and Indirect Labor Cost per 1000 Direct Pts.

FIGURE 2. *A close control of labor costs is facilitated by this ratio summary.*

work to be lowered. The point plan is not, however, as bad in this respect as some other incentive plans. The piece-rate plan, for example, puts a money value on each piece, and this serves to emphasize the necessity for speed at any cost, tending to result in a disregard of quality which is not so much in evidence when the operator is producing points rather than dollars. The point plan has been modified in some plants to combine quality and quantity production, and where these two are used as a basis the above criticism does not hold.

It is customary under the point plan for direct labor to be paid only 75 per cent of their earnings above a 60-point hour. The remaining 25 per cent is placed in a special fund from which the premium is paid to indirect labor, such as foremen, helpers, janitors. There has been considerable criticism of this phase of the plan, since it is not all unlikely that the direct labor will feel that part of their earnings are being given to the indirect labor. The B. F. Goodrich Rubber Company avoided this difficulty by modifying the Bedaux plan which it uses. Mr. C. C. Shipman of the Goodrich Company (Transactions A.S.M.E., Vol. 50, No. 10, p. 54) makes the following explanation: "When the organization with which the writer is connected installed the Bedaux system, a direct departure was made from former Bedaux installations in that the premium paid to the indirect labor as an incentive was paid by the company and had no influence whatever upon the wages paid the direct labor. The amount of premium paid was based on premium B's (points) developed in the department and a percentage of the base-rate earnings.

"At the time 'Bedaux' was installed, premium was only paid as an incentive for labor of effectiveness; later it was found desirable to influence this premium by accomplishments on control of waste, machine maintenance, small tools and supplies, quality of product, and cement and oils. Operating budgets were set on these various functions and the progress collected with the labor on the 'Bedaux' analysis sheets, showing labor effectiveness and labor effectiveness modified by expense items. Premium is now paid on a modified application.

"The standards set are workable, are competitive between departments, and have changed the viewpoint of our foremen to that of managers. The scheme is psychological, and has created interest which has resulted in the development of the operating personnel.

"During the first year in which this system was used the above items were reduced to an appreciable level, resulting in savings to the company many times the cost of the premium paid."

4. In some plants the non-productive labor is divided into a great number of subdivisions (see columns 16 to 23 in Figure 1) and an attempt is made to separate or classify the work done daily into these divisions. It is evident that this is a useless waste of time in many cases. Take, for example, the janitor who does some work involving handling, some maintenance and some work classed as janitor work—it is impractical for this man to ring a time card when he changes from one kind of work to another. Much wasted effort might be saved if all indirect labor were combined and the total ratio used. In some plants this idea is now being adopted to advantage.

5. The point plan does not control direct or indirect material costs, or total unit costs. Perhaps this is not desirable in some cases, but it must be thoroughly understood that cost ratios on the analysis sheet are not total cost comparisons but only a partial analysis.

WORTH PLUS OUTPUT

By W. B. NELSON
Automatic Electric, Incorporated, Chicago

THE key man in manufacturing plants today is the foreman. The success of a manufacturing enterprise is largely affected by the manner in which the foreman links up the management and the men. In this day of great organizations and severe competition, the goal of the foreman must be maximum production at the lowest possible cost consistent with the quality expected. He must never lose sight of this goal and every action must be directed toward it.

The foreman of today is not only the leader of his men and the interpreter of the program of the management to those who look toward him as the representative of the company, but on him is laid also the responsibility of production at minimum cost.

The best way to make the foreman feel his responsibility in this direction and to provide an incentive which will assure the carrying out of the program laid out for his department, is so to arrange his earnings that they will reflect his degree of success in attaining the desired results.

A foreman's compensation should be made up of two parts. The first, a guaranteed basic wage which should reflect the peculiar requirements of his department. It is obvious that a foreman directing the work of a group of highly skilled operators where technical knowledge is essential, should be rated on a different basis from the one who supervises a group on simple assembly work. A foreman in charge of a department working with precious metals must be of absolute integrity and his basic scale should be established ac-

cordingly. The second, an incentive to maximum production at minimum expense.

This incentive should be based on the output of the department and the cost of producing that output. If the incentive is adequate there will be no excess of labor in the department, the minimum of material will be wasted, and no unjustified item of expense will be allowed to creep in.

In a department where the employees supervised are on a piecework or bonus basis of payment, it is a simple matter to provide for the foreman's incentive to high output. It can be arranged on the basis of a percentage of the total piecework or bonus earnings of his operators (not deducted from their earnings) if the output is made up of a great variety of parts or operations. In a continuous process or progressive assembly department it can be a fixed amount per unit of output.

In an organization just being built up it may be necessary, at least during the preliminary building-up process, to base the foreman's secondary compensation on output alone. The point soon is reached, however, where cost of production assumes primary importance and must be considered in the calculation of the foreman's earnings.

The most practical way in which to provide for this factor is to prepare a budget of departmental operating expenses and anticipated output, breaking this down to a unit of expense per unit of output or per productive labor hour. The relation from month to month of actual expense per unit to this predetermined figure indicates the degree of success the foreman is attaining in the program laid out for him. This ratio, set up as percentage relation, and applied to the incentive earnings based on output, gives the final figure which reflects the foreman's skill as an administrator. When added to his basic wage it represents his value to the organization for the period involved.

Set up as a formula this compensation plan may be stated as follows:

$$W + \left(I \times \frac{B}{A}\right) = \text{Total earnings}$$

In which W represents basic wage; I the incentive earnings based on output alone; B the "bogey" expense per unit of output or per productive labor hour; A the actual expense per unit of output or per productive labor hour.

In this set-up it is essential that the expense bogey be determined as scientifically as possible. It is not always fair to base it on past performance as the advantage is then given to the foreman who, previous to the establishment of the plan, has not given sufficient attention to the control of expense. It may be necessary, due to changing conditions under which the department is operating, to revise the expense factor from time to time. The foreman should thoroughly understand every such revision and the conditions bringing it about.

The essential advantage of this plan is its fairness to the foreman and to the company. He is paid for what he knows and for the results which he obtains. The greater his compensation, the greater his value.

BONUS AND OVERHEAD—A NEGLECTED ANGLE OF WAGE PAYMENT PLANS

By J. C. LINDSEY
Seattle, Washington

IT is a matter of disappointment to many managers that the installation of wage and bonus plans so frequently fails to result in cost reductions, although the plans themselves may be effective in increasing output. A result of such disappointment may be that the whole system of incentive payments is condemned and the plant goes back to the anachronistic flat-time wage. One reason for the failure of a wage plan to be effective in reducing costs, may be the failure to understand the effect of increased production on overhead costs, and to take this effect into consideration in planning the wage system.

It has been said by competent authority that less than half the industries of the United States have cost accounting systems and less than 10 per cent of those have adequate systems. It is our belief that not more than the 10 per cent referred to know, in terms of unit costs, the exact relation between the overhead which is affected by volume of production and the wages paid for production. We refer to those overhead items which are functions of time, such as taxes, rent, insurance, time-depreciation and obsolescence of equipment, supervision, service labor, indirect labor, and the like.

The ratio of time-overhead to direct labor is greater than is generally realized.

It is very common to guess that "our labor cost is 40 per cent of our cost of operation." It is not common to appreciate the fact that, if costs of wear-and-tear-depreciation, supplies, and so on, are deducted from this total cost of overhead, as it usually is computed, and if all proper time-overhead costs, such as salaried supervision and indirect labor, are added to it, the direct labor cost (the cost of that labor which is applied directly to the material) will be reduced to 30 per cent of the time-overhead. Nor is it realized that this means a ratio of overhead to wages amounting to about 3 to 1 in many industries. With the substitution of machinery for hand labor this figure, 3 to 1, is increasing rather than diminishing.

New methods of wage payments are coming into the management of industry in America, with all the force recognizable in such evolutionary methods as mass and line production, and consolidations of ownership and management. These new methods of payment are inevitable because they are, in principle, sound and equitable.

The laborer is worthy of his hire, and it is for the purpose of adjusting correctly a balance between worth and hire that we are looking for methods of measurement. For a number of years we have been considering these measurements of work in terms of time-studied and standardized tasks, and of pay for proficiencies and performances of men measured in terms of efficiency, or points produced, or time saved, and in other ways designed generally to meet psychological requirements of the worker. This or that term appeals best to their personal interest in production.

One purpose of this article is to present a bonus plan that will appeal immediately to all workers as fair to them. "Savings divided on a 50-50 basis" was proposed as a wage principle by Ficker[1] a long time ago; but the chief purpose of this article is to present a method by which management, before being committed to any form of bonus-wage plan, can determine accurately whether such a bonus plan will, if paid, actually reduce the unit cost of production and, if so, by how much for each unit of production.

Whether it will pay or not is the first thing to determine in the

[1] An account of the Ficker Plan of Wage Payment is given on page 943 of Managements' Handbook by L. P. Alford.

consideration of any wage plan. We urge first attention to that and furnish a method of computation useful in that attention.

The relationship between wages and overhead may be expressed in a simple formula which indicates accurately the maximum amount which a company can afford to pay of production bonus wages to secure increased output.

If we let: O = the time-overhead, or burden, chargeable to the position, process center, group, or department, for any given period, such as a day or month,
W = the wages chargeable for the same period and
S = the standard volume of production, or volume of service, for the period,

Then the standard unit cost (U) of the given production will be:

$$U = \frac{O + W}{S} \tag{1}$$

And the maximum percentage of the standard wage, W, which can be paid as an incentive bonus rate to induce increased production without increasing the unit cost of production, can be determined from the formula:[2]

$$\frac{O + W + W\,(1 + O/W)\,ip}{S\,(1 + i)} = U \tag{2}$$

[2] Formula 3 can also be derived by the following method, in the formulation of which I desire to acknowledge the assistance of my friend Major Hutton.

Let b = the greatest percentage by which the workman's standard wage can be increased under improved conditions, without increasing the unit cost of the product beyond the standard unit cost. Let i = the resulting increase in production, as before. Then

$$\frac{W + O}{S} = U,$$

the unit cost under standard conditions, must equal the new unit cost
and $S\,(1 + i)$ = the new number of units per hour.
and $W\,(1 + b)$ = the new maximum hourly wage, under the given conditions.

It follows that:

$$\frac{W\,(1 + b) + O}{S\,(1 + i)} = \frac{W + O}{S}$$

Solving for b:

$$\frac{W + Wb + O}{1 + i} = W + O$$

$$Wb = (W + O)\,(1 + i) - (W + O)$$

$$b = \frac{(W + O)\,i}{W}$$

When p = 100 in equation (3) in the text, this formula becomes identical with (3).

in which i = the percentage of increased production and p = the percentage of the maximum bonus rate to be paid the worker.

From this it will be seen that the greatest bonus rate, b, as a percentage of standard wages, which can be paid without increasing the unit cost, is

(3) $$b = i\,(1 + O/W)\,p$$

in which p = 100.

The application of formula (3) may be shown by a simple illustration which shows under a given set of conditions the profit per unit of production to the company on the bonus actually paid, and which shows the increase in wages for the worker.

Assuming overhead to be $2.00 per hour and wages $1.00 per hour, and standard production 100 units per hour, the standard cost will be

$$\frac{\$2.00 + \$1.00}{100} = 3 \text{ cents}$$

In a case of 20 per cent increase in output, and paying the worker 50 per cent of the savings in unit cost, the new cost will be

$$\frac{\$2.00 + \$1.00 + \$1.00\,(1 + 2)\,(.20)\,(.50)}{100\,(1 + .20)} = 2.75 \text{ cents}$$

This is a saving of .25 cents per unit on 120 units, or 30 cents. And the increased wages will amount to

$$\$1.00 + \$1.00\,(1 + 2)\,(.20)\,(.50) = \$1.30$$

This is an increase of 30 cents per hour or 30 per cent for the worker.

If the ratio of overhead to wages had been 3 to 1, the standard wage $1.00 per hour, the increased production the same as above, and the divisions of savings the same, the bonus wage would have been $1.40 per hour with, perhaps, no increased effort on the part of the worker. But this is in full accord with the principle that higher wages should be paid to workers in positions where they can save the most in costs, even though the efforts and skill exerted in increasing production are just the same as those of workers not in such important positions. This plan effectively directs, by a wage incentive, the greatest efforts in increased production to those process or production centers where the greatest saving is to be

made in unit costs. And, assuming that these centers are occupied by men of the highest skill, the plan is in accord with Mr. Taylor's principles that not only the greater standard wages but also the greater increases in wages should be paid to the most skilled men.[3]

If the full implications of the reasoning so far developed are accepted, then the least bonus that should be paid the worker is a percentage of his standard wages equal to the percentage of production over standard production achieved by him. In other words, the bonus rate as a percentage of wages should not be less than 100 per cent of the percentage of increase in production; which works out as a straight piece rate on the entire production, the piece-rate wage cost being equal to the standard wage divided by the standard number of production units. .

In any plan decided upon there should be, of course, a division of the savings for the company. Management (the company) should be compensated for the more detailed cost accounting and closer attention to production when output is to be measured carefully and recorded. It should be recognized, too, that the management is as human as is the working force and needs just as much an incentive to close attention and effort. It was an hourly wage worker who told me that no bonus-wage plan which does not also pay a profit to the employer can be expected to be a permanent plan.

But to say that the employee is being paid the premium to which he is fairly entitled and to show him a plan adopted for all departments alike regardless of variations in related overhead, or to tell him that he is to be paid an arbitrarily graduated scale of wage percentages varying with his production percentages at a rate of variation he does not and cannot understand, and which in the long run does not pay him per units of production as much as his standard production at his standard wage, is to confuse and irritate him rather than to encourage him to his best endeavor in personal effort, co-operation, and self-supervision.

It is a mistake to act on the assumption that the bonus-wage group will react favorably to an incentive wage they do not understand; or to assume that they cannot be made to understand a bonus which is fair to them. Once they are being paid under a bonus-

[3] *Piece Rate System*, by Frederick Winslow Taylor (p. 64), published by George Routledge & Sons, Ltd., London, 1919. A paper presented at the Detroit meeting of the American Society of Mechanical Engineers, June, 1895.

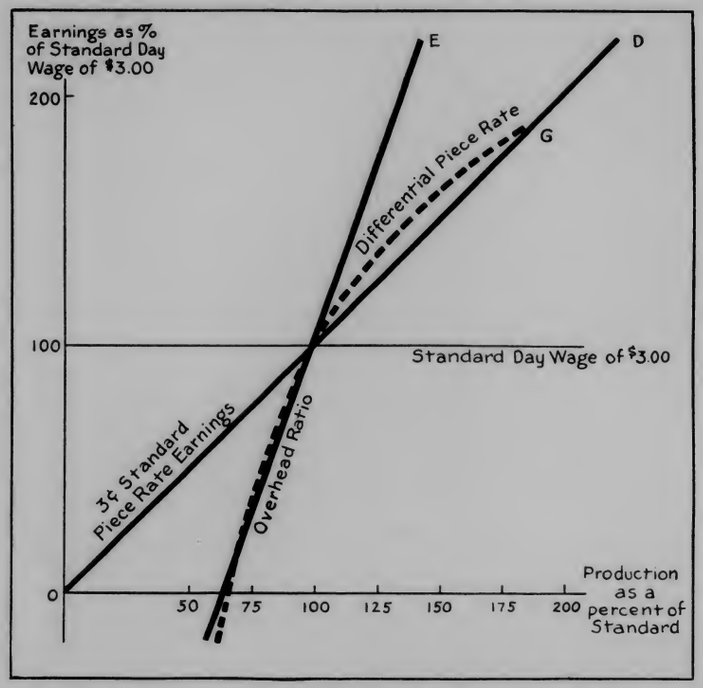


FIGURE 1. *How the differential piece rate varies in comparison with the standard piece rate, with a ratio of overhead to wages of 1 to 1. The dotted curve F is the differential rate, which is identical with the piece rate (the heavy line at D) at standard (100 per cent) production. It exceeds the piece rate below standard and rapidly decreases in relative cost for performance above standard.*

wage plan it becomes the thing uppermost in their thoughts. If it is logical and clear in itself, you may depend upon it that they can understand it. It once took me less than two minutes to show a workman of meager grade-school education how to compute, on a cheap slide-rule, the hours allowed him by the Barth plan; and that plan is regarded, generally, as most complicated.

The statement as to the probable reactions of the men is based upon actual experience in the service of firms with over 20,000

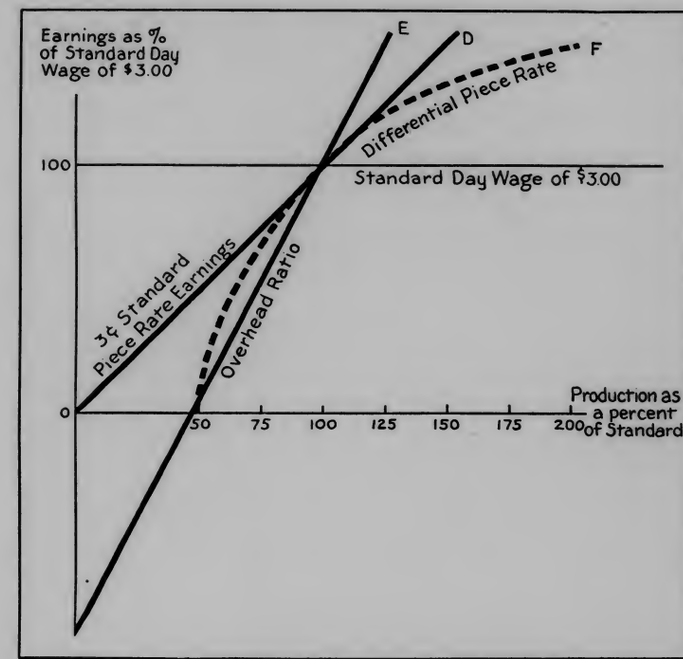


FIGURE 2. *How the differential varies when the ratio of overhead costs is 2 to 1. The set-up of this chart corresponds to that of Figure 1.*

workers, ranging from loggers, longshoremen and coal miners to college-bred electrical engineers. I don't know one man in any of these groups who cannot understand a clear statement of the principles outlined, not even the engineers. Nor will one of them object to receiving a bonus while other departments are paid a higher rate, if he is given a chance to understand the reason for the apparent discrimination.

The application of the plan can best be made by means of an announcement, the essence of which I am repeating, with brief explanations, in what follows:

(1) "The bonus rate as percentage of standard time-wage or piece-rate earnings will be at least equal to the percentage of pro-

duction in excess of an agreed standard rate, or quantity, of production. For example, it will be at least 10 per cent of wages for as much as 10 per cent of excess production."

A table may be published to accompany this announcement, showing the benefit the men and the company will each receive from the payment of the announced bonus, for performance at various rates of output or percentages of the standard rate of output.

On the basis of paragraph (1) in the announcement, and assuming it is decided to split the savings on a 50-50 basis, the management can then say to the men in a department in which the ratio of overhead to wages is 2 to 1:

(2) "The production for this department has been computed as (so many) units of production per man-hour. When you increase this rate of production by 10 per cent you will be paid your regular wages or piece-rate earnings increased by 15 per cent, or at the rate of 1½ per cent increase in wages for each 1 per cent increase in production."

In Table A we have shown the result of applying, to a varying list of overhead conditions, a common rule of paying a bonus rate equal to 1½ times (or 150 per cent of) the rate of increased pro-

TABLE A

BONUS RATE IS (PERCENTAGE OF INCREASED PRODUCTION) x 1.5

(1) Ratio of Overhead to Wages	(2) Percentage of Increased Production	(3) Maximum Bonus Rate Possible to Pay Without Increase of the Unit Cost	(4) Percentage of Standard Wages for Standard Production to accrue as: Bonus Rate to the Employee	(5) Savings for the Employer
.5 to 1	25	37.5	37.5	0
1 to 1	25	50.	37.5	12.5
1½ to 1	25	62.5	37.5	25.
2 to 1	25	75.	37.5	37.5
2½ to 1	25	87.5	37.5	50.
2½ to 1	25	87.5	37.5	50.
3 to 1	25	100.	37.5	62.5
3½ to 1	25	112.5	37.5	75.
4 to 1	25	125.	37.5	87.5

duction. This seems the simplest of bonus rates, but note that it results in a 50-50 division of the total savings only when the ratio of overhead to wages is 2 to 1.

Table B illustrates the bonus rates and the savings in columns (4) and (5) respectively, when, instead of saying to the men in a department in which the ratio of overhead to wages is known to be 2 to 1, that the bonus rate will be 150 per cent of the increased rate of production (which would, in the case illustrated, be 37½ per cent), we say to an entire plant, including a number of departments under varying rates of overhead, that the bonus will be a 50-50 split of the savings in total manufacturing unit costs resulting from increased production.

The announcement we suggest in this article is to be varied, in respect of this bonus percentage, in every department according to the overhead ratio in that department. The result is the same as that of the general announcement because the announcement of 1.5 per cent bonus for each 1 per cent of increased production is designed for a department in which the overhead ratio is 2 to 1.

As a constant incentive to continued improvement in production or decrease in costs, the following clause may be added to the announcement:

TABLE B

BONUS IS ONE-HALF THE SAVINGS IN UNIT OPERATING COSTS

(1) Ratio of Overhead to Wages	(2) Percentage of Increased Production	(3) Maximum Bonus Rate Possible to Pay Without Increase of the Unit Cost	(4) Percentage of Standard Wages for Standard Production to accrue as: Bonus Rate to the Employee	(5) Savings for the Employer
0.5 to 1	25	37.5	18.75	18.75
1 to 1	25	50.	25.	25.
1.5 to 1	25	62.5	31.25	31.25
2 to 1	25	75.	37.5	37.5
2.5 to 1	25	87.5	43.75	43.75
3 to 1	25	100.	50.	50.
3.5 to 1	25	112.5	56.25	56.25
4 to 1	25	125.	62.5	62.5

(3) "When you can so reduce the total cost of wages in your department as to increase the ratio of overhead cost to wages cost in that department, this percentage will be increased."

And as a corollary to the above, to show that slacking off in effort has its penalties, the following might be added:

(4) "When the cost of wages per unit of production has been INCREASED, by REDUCED production per man-hour, so that the ratio of overhead to wage costs is DECREASED, the bonus rate will be decreased accordingly; but not below the ratio of 1 to 1."

I refer to this announcement as an incomplete statement of the plan because it does not explain in detail to the employees the effect of increased output upon the overhead costs per unit of production. It is easy to make the announcement complete by adding that explanation.

Workmen have had reason in the past to be suspicious of bonus plans, as well as of piece rates which were cut when their earnings went up to an unaccustomed point. This suspicion fully justifies the addition to the announcement I have suggested of some such statement as the following:

(5) "When conditions have been changed by the introduction of new machinery or new methods by management, as a direct result of which the rate of production is increased or diminished, the present standards of production will be changed accordingly. But if the rate of production is increased by greater skill or effort on the part of the men to be paid the bonus wage, the standard rate of production, upon which the bonus wage is to be based, will not be increased."

Even for the management which believes in aloofness and discipline rather than inspiration and encouragement as methods of increasing co-operation and production, it will not be a serious mistake if some such statement as the following is added to the announcement of the installation of an incentive-wage plan.

(6) "Our accounting will be fair and honest. Be fair with us and with yourselves; increase our output, reduce our costs, and increase your earnings. Our interests, under this wage plan, are mutual."

When actual figures for these savings in unit costs are computed it is no wonder wise managements are delighted with the results from the use of incentive wages as a means of speeding up production. They not only do speed up the rate of production, as can be observed readily on the job, but they reduce unit costs, which can be seen in the cost sheets in no uncertain terms.

If more managements knew the relations of their time-overhead cost to their costs, knew the profit there is in increased production, and the effectiveness of incentive wages in achievement of increased production, there would be less adherence to the anachronistic level time-wage or the flat piece-rate wages, and more co-operation, profit, and happiness in industry.

LET INCENTIVES TALK IN DOLLARS

By E. E. BRINKMAN

Industrial Engineer, Holeproof Hosiery Company, Milwaukee

THE trouble with many wage-payment plans is that they place an unbalanced emphasis on some one phase of production, with the result that the other phases equally essential, are neglected. Day rate emphasizes quality but fails to give adequate stimulus to output. Straight piece rate, with adequate inspection, secures stimulus and at least the minimum required quality, but provides no incentive to saving of material. Many bonus plans share the merits and defects of piece rate.

When a wage plan thus distorts compensation, the worker has one of two alternatives. If he is going to maintain the type of work dictated by his conscience and standards of workmanship, he must do so at his own cost. If he decides to capitalize the weakness of the employer, he does so at the sacrifice of his standards. The tendency is to become satisfied merely to get by.

Either alternative means a conflict, a conflict of employer's and employee's interest, which in turn results in conflict between what the workman knows is right and what he finds is expedient. It should be the purpose of any sound wage plan to resolve these conflicts, and so to balance the payment for the various phases of the job that the interests of employer and employee are substantially in harmony.

The many factors which influenced the effectiveness of the work in the Holeproof Hosiery plan resolved themselves into three phases

Incentives for increased production, improved quality and reduced waste keep rib-top knitting machines running with a small percentage of defects.

or categories of primary importance. These categories are output, quality and saving of material. The problem of securing a balanced incentive resolved itself into giving sufficient weight to each of these phases so that the pull of each phase would be approximately equal. To secure this balance we needed to measure the resistance and the importance of the job, experimentally, much as foot-pounds of work may be measured. We needed data, much the same as the data used for control purposes by the management. The important factors of production — quality in terms of defects found in inspection, and cost of production in terms of excess of actual over standard material waste—were all reducible to dollars.

Since a saving of $100 is important to the employer regardless of the factor on which it is made, it follows that a balanced incentive intended to create equal interest on all three factors can be secured by computing rewards proportional to the dollar savings on each factor. All tangible results of operations may be thus evaluated in money terms. On results of operations producing an intangible effect (such as poor quality) resulting in loss of good will due to dissatisfaction on the part of the customer, the effect can usually be evaluated, at least arbitrarily for the purposes of wage computation, under an incentive.

Two examples of the application of these principles will be given. The first case is that of an inspector, the second, a foreman.

The methods used to arrive at the balance of factors for the three phases in the case of the inspector are as follows:

Phase 1. Quality of Hosiery Inspected.

The method of hosiery inspection has been definitely established by motion-time analysis, prescribing the exact motions and standard time for them. Following the specified motion in accordance with training enables the inspectors to produce standard output. Quantity is in this case paid for on the basis of a standard time unit by the following simple computation:

(Number of dozen inspected) $\times$ *(standard time unit)* $\times$ *(base rate)* $=$ *(earnings for quantity of production).*

Phase 2. Quality of Perfects Passed.

Defective hosiery is separated from perfect in accordance with definitely prescribed quality standards given in a manual of inspection rules.

Transferring the rib tops to machines where leg and foot are knitted requires skill and care. Here wage incentives are based on absence of defects, reduction of spoiled material and improvement of finished product.

The accuracy of this separation of imperfects from perfects is of prime importance and is measured by a system of spot re-inspection. This re-inspection gives the percentage of errors made by the inspectors. As the accuracy of the inspection is dependent upon the degree of familiarity with the inspection rules and the degree of concentration of the operator in his search for defective spots, it is appropriate to induce this condition in the operator by an incentive based on the results. Computations of reward or penalty on this factor are made by comparing actual percentage of defects with the allowed percentage of error according to the following formula:

(Actual per cent defects — standard per cent error) × 10 × (pay earned on factor 1) = reward or penalty.

This result may be either a gain or loss. It is added algebraically with earnings on the other two factors. Attention is directed to the use of a multiplying factor of 10, to make the formula correspond in pay results with the variations in quality of work. This multiplying factor makes the incentive on this phase of their work as powerful as the quantity incentive in factor 1.

Phase 3. Waste of Material.

While this inspecting operation is of such a nature that no raw material is consumed in its operation, there is still present the possibility of the operator's rejecting too many perfects in her zeal to achieve a high quality classification. The waste resulting from this practice is as serious as the avoidable spoilage of good yarn in the knitting process. In order to balance this phase of this job with phases 1 and 2, an incentive is provided. Spot re-inspection measures and controls this. Computation of pay earned on this factor is the same as for factor 2.

Summarizing these three factors and applying them to a representative case, the pay for an inspector would be computed as follows:

Factor 1—1200 dozen × standard time unit of .05 hours × base rate of 60c per hour = $36.00.

Factor 2—(Actual of 1.8 per cent defects — standard of 1.5 per cent) × 10 × $36.00 = $1.08.

Factor 3—(Actual waste of 1.1 per cent — standard of 1.5 per cent) × 10 × $36.00 = $1.44.

Adding these factors algebraically ($36.00 — $1.08 + $1.44) gives $36.36 as the total pay.

The second case is that of a foreman of the knitting department. While the principle is the same as in the case just given, the values are more intangible, must be determined more by trial and error and must be adjusted more frequently to changes in manufacturing conditions. We found that for foremen the cost basis provided the logical and most flexible system, meeting all changes and still maintaining a proper balance of interest.

The comparison shown below indicates the basis for computing foreman's bonus:

	Standard	*Actual*	*Gain*
Units of production	10,000	10,000	.....
Direct labor cost	$10,000	$9,800	$200
Indirect labor cost	3,000	2,950	50
Material cost	40,800	40,500	300
Imperfects produced	600 units	500 units	100 units
Loss on imperfects produced at $1.00 each	$600	$500	$100

The above data enter into computation of premium on each of the three factors as follows:

Factor 1. Production and labor cost (cost factor); total gain or loss:

Gain on direct labor	$200	
Gain on indirect labor	50	
		$250.00

Factor 2. Material consumed (waste factor):

Gain on waste over standard waste	300.00

Factor 3. Quality of output (imperfect factor):

Gain on reduction of imperfects below standard	100.00
Total gain (net) on all factors	$650.00
Foreman's premium at 5 per cent of net gain	32.50

All factors have been converted to dollar values on the basis of actual cost records. This makes possible an incentive on each of the three factors of such size that it is in exact proportion to money saved or lost by changes in operating conditions on each factor. In other words, a foreman is induced to give a possible saving of $1,000 ten times more attention and pressure than a possible econ-

In this finishing operation credit is given for improved quality as well as high production.

omy of $100 on another factor. When the foreman does this, his department is then operating on an even keel of low cost, high quality production, at a minimum waste.

This principle of incentives is not confined to any one wage system. A number of these systems, such as piece rates, 100 per cent time premium and Halsey premiums, have been adapted to operation under this plan. Wherever possible, the computation of results should be simple. Because there are three factors entering into the determination of pay, it is highly desirable to compute separately the pay on each factor. This promotes ease of understanding by the worker and enhances the effectiveness of the wage incentive. The worker should be able to interpret his effort expended on any factor in terms of the money results to the company and to his own purse. He will gradually acquire a feel of the incentive and comes to know almost instinctively the amount of attention to be devoted to each factor of his job.

The operation of this principle of balanced three-phase incentives is dependent upon standards with which actual performance is compared. It is essential, therefore, that all standards of time, cost, material, waste, perfect quality and ratio of defective output be established with the most accurate and efficient methods available.

One word more. In the interests of stability and good faith, it is important that time standards should not be subject to change without corresponding change in method or equipment.

SUPERVISION WITHOUT SUPERVISORS

By BROOKS SHEPARD
Secretary, the Eberhard Manufacturing Company, Cleveland

ONE of the finest things about piracy was the wage-payment plan which it contributed to industry. Morgan, Kidd, and other leaders in this industry realized that payment on a day-work basis failed to provide sufficient incentive to the individual employee. Piece-work rates were obviously impracticable because of the difficulty of arriving at standards, and because of the virtual impossibility of providing a constant flow of work to each employee. A group bonus system was therefore worked out, and its application produced gratifying economies. Where two strokes had formerly been required to cut a throat, the weasant was now slit in a single swift slash. The workers assisted one another in innumerable small ways, for it was to their common interest that the job be completed in the shortest possible time. As a result, the industry grew very rapidly, until government restrictions made it unattractive as an investment.

We are slow to perceive the analogies between other industries and our own, which undoubtedly explains why the merits of this system have so long been overlooked by the men who go down to the sea in books.

In our own plant we have experimented rather unscientifically with group payment for group accomplishment, and have secured surprising economies. Some of these we expected. Others we had not foreseen at all; and it has been characteristic of this plan, during its gradual application to different types of activity, that new possibilities of extension and refinement are revealed at every turn.

It should be made plain that the large savings we have made in certain departments through the application of gang piece-work are due in part to the high costs which prevailed before its application. For nearly half a century our plant had operated profitably, supplying malleable iron hardware to vehicle and harness manufacturers. The builders of carriages and wagons depended upon us for their castings; their product had become standardized about our stock line, and the goad of competition scarcely pricked us. We became

mellow and genial, and we drowsed pleasantly in our autumnal garden, while a bustling city grew around us, and presently closed us in. The details of Uncle Henry's rejuvenation need not be touched upon here, and the brief tale of his temporary baldness is told in order that the reader may not be startled by the savings which this informal and honest paper describes. It is also mentioned as an encouragement to those who have allowed themselves to lag behind in the industrial procession. It is possible to catch up, to effect great economies without the expenditure of a penny; and to carry out a radical program of modernization without drastic change in the operating personnel of the works organization.

There is nothing new in the idea of group payment for group accomplishment. Karl Marx thought of it long ago, but sentimentalism blinded him to its limitations. His gang comprised the whole human race, which is too large, even under Divine supervision, to function efficiently and harmoniously. He provided no supervision whatever. His gang was autonomous, a headless monster. He provided no incentive for individual achievement, for he ignored the differing abilities of men, and the essential rightness of a reward proportional to ability and achievement. But he perceived this vital truth: that when men depend upon one another for their livelihood, and are sharply aware of this dependence, they will help one another, not hinder. What he failed to realize was that men do not perceive this interdependence unless the relationship between their tasks is obvious.

We were driven into a study of gang piece-work because of the enormous variety of our product and the virtual impossibility of establishing a payroll accounting system based upon individual piece-work rates. Our foundry produces castings from the 12,000 different patterns which comprise our catalog line and are carried in stock for immediate shipment. Many of these items are produced several times in the course of a single year, on small repeat orders. In addition to our stock line, we manufacture an immense variety of castings from customers' patterns. Its aggregate tonnage is greater than that of our catalogued product, and its variety is nearly as great.

The difficulty of establishing individual piece-work rates for this kind of production led us to consider the possibility of a group-payment plan for certain types of activity—especially those activities in which large groups of men were doing work of a similar character.

Obviously, such a plan was unnecessary in our molding and machining operations, where individual piece-work rates could be readily applied after standards were established through time and motion study. Here the operator handled each piece individually and for approximately the same length of time. The difficulty of equitable pay arose in the departments in which a small group of men handled a large tonnage, performing brief miscellaneous operations upon a huge variety of castings. The distinction should be made clear, and a simple illustration will crystallize it.

Your health having failed through your strenuous efforts to meet competition, your doctor orders you to Arizona. You buy a cattle ranch, and attempt to run it on a Men, Methods, and Materials basis. Branding is 45 cents per 100 cows, less 10 cents per typographical error. Easy enough—and the cowboy is satisfied. But how will you pay the men who round up these wretched cows? You can't charge to any one man the time spent in chasing any one cow, for a round-up is no place for a man with a stop-watch. Obviously, the only fair method is to estimate the number of men needed for the task, and the time required to concentrate those fool cows in a given area; after which the pay for the job is distributed among the boys according to their experience and estimated ability. The veteran receives a larger share than the greenhorn, and the boys are satisfied.

In planning the application of gang piece-work, we chose for the first experiment our vehicle hardware stockroom and shipping department—not because this department was obviously adapted to gang piece-work, but because the department had long been a fly in the managerial butter. Twenty-six men, most of them hearty, honest Irishmen, were employed to do work which we were convinced could be accomplished by two-thirds of their number. They packed and weighed and checked with a sort of massive leisure. Nothing disturbed their Arcadian calm except the occasional arrival of a new employee, who was compelled under threat of practical annihilation, to learn the gentle art of seeming busy. (This is preeminently, though not exclusively, an Hibernian art. Set a big Irishman in the pose of Atlas and you can scarcely believe he is not carrying an immense weight!)

This idyllic life was shattered by the application of gang piece-

work. After an informal but shrewd study of lost motions, 12 of the 26 men were dismissed. A fixed rate per ton was established, to be divided equally among the 14 remaining men. This, however, took no account of the varying abilities of these men. They were therefore graded by their foreman according to their different abilities, and were assigned supplementary day-work rates varying from three cents per hour for the less able men, to 25 cents per hour for the more experienced. Our method of grading these men was not strictly modern. Instead of tabulating their vices and their virtues, and striking a mathematical balance, their foreman merely listed them in the order of their usefulness to him. We would have been scientific about it, but we could not find any two authorities who agreed as to the virtues and vices which ought to be considered in tabulating a man. The fact that none of these men considered his grading unfair suggests that the yardstick of usefulness may be satisfactory until the Bureau of Standards has decided what constitutes the measure of a man.

Let us consider the effect of this graduated payment upon the cost of the department and upon the earnings of the men. Their fixed rate per ton was calculated to provide a reasonable wage, even without their day-work bonus, during times of normal business. It constituted much the larger part of the department payroll, and as it varied with the tonnage shipped, it insured a definite relationship between the payroll of the department and the volume of business enjoyed by the company. In times of active business the men have profited by our increased tonnage, for they have chosen to work longer hours rather than to increase the size of their group. In slack times they have gone home early. Their supplementary day-work rates are too small to encourage stalling for time.

The mediocre man whose premium is only three cents per hour will not put in a needless hour's work for this sum. The higher-class worker will not do it for his larger premium of 25 cents per hour.

The effect of this plan during a month of normal shipments was to reduce the working force 46 per cent and the department payroll 33 per cent. The pay of each man in the group was increased, on an average, by 25 per cent. The group plan of payment made every man an overseer of his fellows, and greatly simplified the task of supervision.

We have applied this method of pay to nearly all of the departments directly associated with the foundry. We have established

it in our rolling or tumbling department, in which a variety of castings are rolled in steel barrels to rid them of sand. These castings vary in weight from a few milligrams to 100 pounds or more, and they come from the foundry in endless variety. If each man in the department worked independently, he would attempt to load his barrel with the heavier castings, and to secure for himself the various advantages of weight, proximity, and ease of handling. The companion who needed temporary assistance would not receive it, but might waste 10 minutes upon a physical task which two men could perform in as many seconds. It is desirable to load a tumbling barrel with large and small castings, the smaller acting as tumbling stars in abrading the interstices of the larger; but this economy cannot be achieved when each man in the group is scrambling after tonnage.

We have applied gang piece-work in our annealing department, our straightening department, and the department in which grinding or snagging is performed. Whether the new method superseded day work or straight piece-work, the resultant economies were large. It was in our trimming and sorting room that the most startling results were obtained. A constant stream of heterogeneous material passes through this room on its way to the annealing department. Fins and webs are chipped from the rough castings, and defective material is thrown out. This has always been an extremely important department with us. Most of our castings are machined in our own plant, and their quality is a vital factor in our machining costs.

A few years ago we employed 94 men in this department. In February of this year, 19 men handled approximately the same tonnage. There has been little change in the method of handling material, or in the operations performed by these men; yet the labor cost has been reduced nearly 75 per cent, and the earnings of the survivors have increased. The big men handle the big castings, and the nimble-fingered men handle the little castings. They organize the flow of incoming and outgoing work, and they help one another in innumerable small ways, for it is to their common interest to get the work out with the greatest possible dispatch, lest the management should find it necessary to increase the size of the group and thus decrease the earnings of its individuals.

In our japanning or enameling department, a saving of over 50 per cent has been made. Part of this saving is due to a change in method which was made simultaneously with the establishment of

gang piece-work; but the greater part of the saving may be attributed directly to the method of pay.

Applying it to our electroplating department, we encountered a peculiar phenomenon. At the end of the first pay period, we found that the earnings of the group were considerably less than they had been under the former system of pay. The calculations on which we had based a gang piece-work rate were hastily reviewed, and were found to be correct. The department was visited, and large quantities of unworked material were found. Surprising quantities. Tons and tons. It was fortunate that this material had not been urgently needed during the week, for the department had been virtually non-productive. Its employees had heard of the large wages earned in other departments, and assuming that gang piece-work automatically resulted in huge wages, they sat around in eager excited groups all week, expecting a raise but doing no work. As the laugh was on the management, it paid the difference, but not without kindly words of guidance.

I have mentioned that each man becomes the self-appointed overseer of his fellows. We anticipated this, of course, but we had not realized how effectively this supervision would relieve the foreman of disciplinary problems. A man may quail before 12 good men and true in a court room, but it is a feeble and a paltry quail compared with his shimmy before a jury of his co-workers. The former may be ignorant of the numberless ingenious ways by which a man may give the impression of bustling industry while actually accomplishing nothing; of keeping his surface ruffled while his depths are unmoved. His fellows are not ignorant of these devices. Like himself, they are adepts in the black or dark gray art of dissimulation; their keen eyes note that the barrel he pushes on a truck is only half filled with castings, requiring an extra trip; that the casting he pounds so earnestly on the straightening bench was straightened at the first wallop, if it was not actually straight when he got it. The prolonged straightening trick is a day-work device for making the day pass. Needless straightening is an individual piece-work wrinkle. Both disappear under gang piece-work. The gang is paid so much per ton for straight castings, and gets its day's work accomplished as expeditiously as possible.

In every group there will be found two or three men who keep their foreman constantly informed as to the malpractice of other members of the group. Laziness is reported, and carelessness, and

meditation in the toilet. If a man persists in delaying the work of the group, his dismissal is tacitly approved by the group, whose interest is identical with that of the management.

It may be objected that our approach to this method of group incentive was not scientific; that we "believed" this, and were "of the opinion" that, and put our plan into operation without the exhaustive scientific study which ought to precede and accompany each move of modern management. But we have encountered so much balderdash under the bright label of "science" that we cannot refrain from pointing out that in human relations there are a thousand variables, concerning whose interplay a thousand different "scientific" opinions may be had. Calling management a science does not make it a science. It is still a philosophy, with warring schools. The head of our cost department, who is largely responsible for the successful application of our gang piece-work plan, used what scientific data were available and used them in a thoroughly scientific way; after which art was applied to complete the job. Science will enter more and more into the conduct of affairs as proved data are accumulated and tabulated; but we feel that in business, as in music, and religion, and the mixing of drinks, art will always have a place. It may not be dignified, but it has its uses.

INCREASED EFFICIENCY MEETS THE PAYROLL

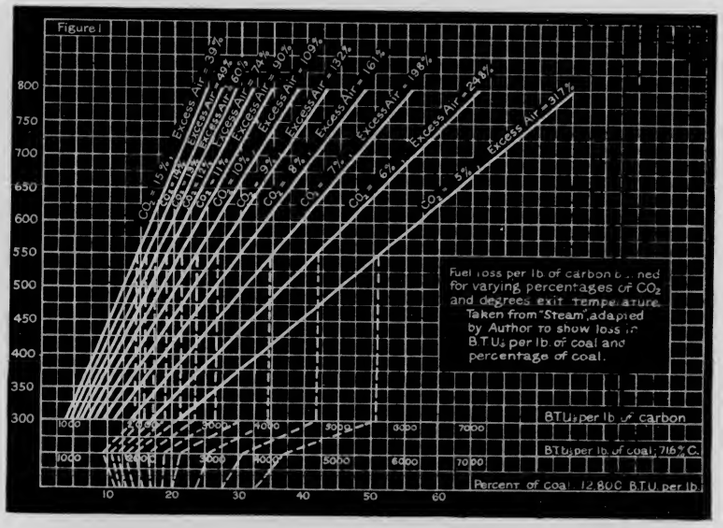
By M. J. Hess

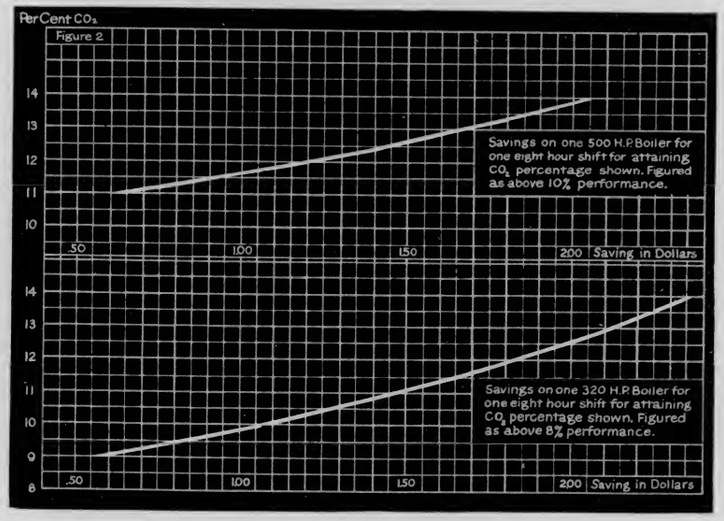
Assistant Plant Engineer, T. M. Sinclair and Company, Limited, Cedar Rapids, Iowa

IN LINE with the installation of an incentive wage system in other departments at the plant of T. M. Sinclair and Company, Limited, pork and beef packers at Cedar Rapids, Iowa, in January, 1928, we decided to devise an incentive plan for the boiler room. The following description of this plan indicates the procedure. With little variation it can be adapted to other boiler rooms.

The boiler room at our plant consisted of two 500-h. p. boilers of recent design and four 320-h. p. boilers of obsolete design. We used Illinois coal having a carbon content of 71.6 per cent, 12,800 B. T. U's as fired, and an ash content of 12 per cent. The coal was unloaded from the cars into piles in front of the boilers then shoveled into the hoppers of the chain grate stokers.

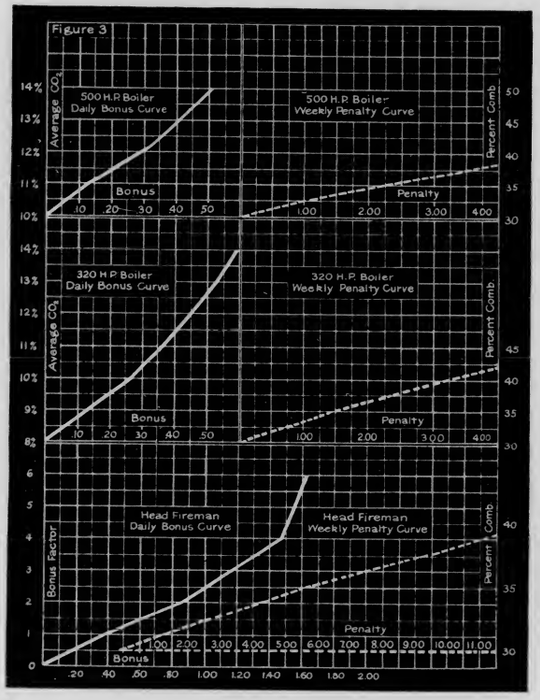
The average coal consumption was 80 tons per day at a cost of





$4.40 at the boiler. The feedwater was heated, treated, and metered, but the only check on the coal used was the weights of the cars as delivered. One head fireman had charge of each shift of two to four firemen, depending on the load carried.

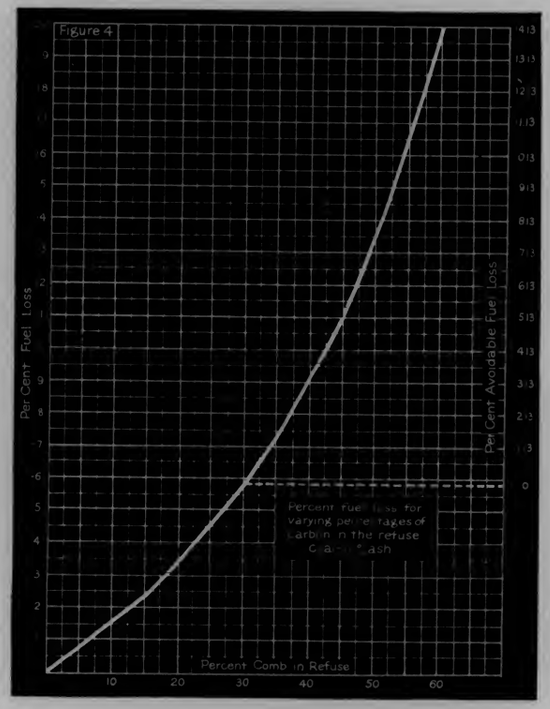
The purpose of the incentive plan was primarily to interest the



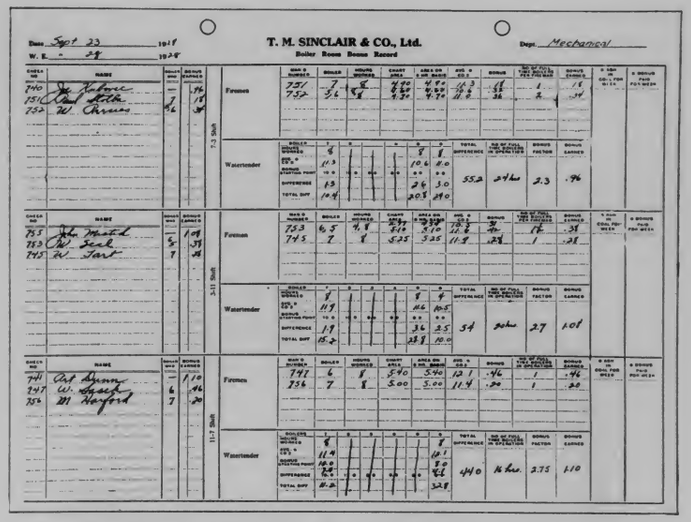
firemen in using the newly-installed CO_2 recorders, get them to maintain a high CO_2 record, and consequently to increase the efficiency of their boilers and effect a saving in the coal bill.

CO_2 recorders give a continuous automatic record of the percentage of carbon dioxide in the flue gas. This record is an indication of the extent of the largest single boiler-room loss—that due

to the use of large amounts of excess air in the combustion process. Inasmuch as combustion is a chemical combination of the carbon in the fuel and oxygen from the air, the analysis of flue gas for CO_2 content will tell whether or not air in excess of this requirement has been taken into the furnace (assuming that combustion is complete).



In boilers not equipped for measuring this loss, it may amount to as much or more than all the other boiler losses combined. All excess air must be heated from the boiler-room temperature to the temperature of the furnace, robbing the boiler of heat which could be used to advantage in producing steam. Obviously, the reduction of this loss means an increase in boiler efficiency.



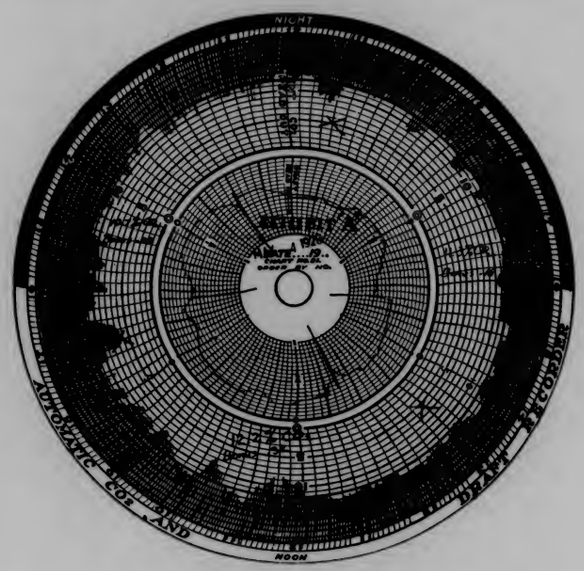
Daily bonuses are calculated from the "attainment" sheet. One copy of this goes to the methods and production department and the other to the timekeeper

The determination of the loss indicated by various percentages of CO_2 is a chemical problem and can be worked out very accurately. For our problem, however, we considered it sufficently accurate to utilize the loss as calculated from the carbon content only. This is shown on the curve which is reproduced from "steam" in Figure 1. This curve shows the heat carried away by the escaping gases per pound of carbon burned, and at differing degrees of flue-gas temperatures. The curve has been adapted to show the loss in percentages of the fuel used at our plant, taking a temperature of 550 degrees as representative.

Knowing the losses occasioned by different percentages of CO_2 the next step was to determine standard performance for our boilers. This was done by running each boiler for a test run after it had been down for its periodic cleaning and inspection. These tests were run with the assistance of the operating engineer. Various thicknesses of fuel bed and damper settings were tried in an effort to determine the best operating conditions. As a result standards were set at 12

per cent CO_2 for the large boilers and 10 per cent CO_2 for the small ones, with a flue gas exit temperature of 550 degrees for both.

Savings were figured on each boiler for the average day of 80 ton coal consumption, figuring the saving for attaining standard performance and exceeding it, using 2 per cent below standard as a starting point. These savings were figured on CO_2 percentages only, and at a constant flue gas exit temperature of 550 degrees. The variations in temperature were assumed as a responsibility of



Bonus factors can readily be computed from this graphic record of the carbon dioxide content of the flue gas

the management as they are largely a reflection of the physical condition of boiler tubes or baffles, and the rate at which the boilers are run. The curves shown in Figure 2 represent the savings as figured.

In determining just how the savings realized should be distributed several points were considered. First, we must admit an inaccuracy

in our method as compared with a direct calculation of boiler efficiency and make allowance for it. For instance, certain other losses may creep in as the CO_2 percentage is raised, tending to offset the savings made. Secondly, the investment of the company in meters, and in additional clerical help was considered. In our case it was arbitrarily decided to divide the savings made with the men on about a 50-50 basis.

The bonus to be paid on each boiler on this basis is shown by the curves in Figure 3. The head fireman's bonus must be based on both the large and the small boilers, so a bonus factor was used. This is simply the per cent above 8 or 10 per cent CO_2 for the small or large boilers. It will be observed that no additional bonus was figured for attaining above 14 per cent CO_2. This is because we found a percentage of CO appearing at that point which is an indication of incomplete combustion, and a loss which might offset any savings attained by eliminating excess air.

An example of attainable bonus, assuming an average day with two large boilers and one small one on the line, and all attaining standard performance is as follows:

FOR 1 8-HOUR SHIFT

	Small Boiler	Large Boiler	Large Boiler	Head Fireman	Total
CO_2	10	12	12	....	....
Savings	1.06	1.14	1.14	....	3.34
Bonus	.26	.28	.28	1.00	1.82
Savings to the company					1.52

This bonus should be sufficient to keep alive the interest of the men, increasing, as it does, to considerably more as "above standard" conditions are attained. The head fireman was given a large percentage of the bonus because the responsibility rests directly with him, and his efforts, more than those of the individual fireman, influence boiler performance.

We considered in our design, as mentioned before, the possibility of a CO_2 loss creeping in, and cutting down on the possible savings. We provided for this loss by not encouraging any higher percentages of CO_2 than 14 per cent.

One other possible loss was considered in our design—loss due to large amounts of unburned coal in the refuse. The firemen, in

their effort to keep a "long" fire to shut out air, may run a large percentage of unburned coal into the ash pit. We established a penalty, based on the percentage of combustible in the ash, which would deduct from their bonus in direct proportion to this avoidable waste. This loss (figuring 30 per cent combustible as allowable) is shown by the curve in Figure 4. The penalty curves for each boiler and for the watertender are taken in the same proportion as the bonus curves and are shown in Figure 3 with the bonus curves. Ash samples are taken each day for each shift and deposited in large sealed cans. From these cans a composite sample is taken each week and the per cent combustible in the ash of each shift determined.

A recent boiler test showed operating efficiencies of the large boilers of 68 to 70 per cent with usual operating conditions. This is about the best operating efficiency that can be expected with equipment such as ours. It demonstrates conclusively that it pays to maintain an interest in good CO_2 performance.

Of course some opposition had to be met on the installation of this system. The inertia of previous methods had to be overcome, and the men educated to new methods of firing. Gradually they were won over and, as they began to earn a bonus, the system sold itself. A weekly check on the boiler room over-all efficiency has shown a steady increase since the installation of the system.

Date Due

~~Apr 30~~		APR 15 '58	
Apr 9	4/6		
MAR 30 1946			
DEC 21 1946	1/4/47		
MAR 7 1947	3/24		
FEB 15 1950	2/29		
OCT 23 1950	11/6		
SEP 27 1950	11/10		
NOV 16 1950	11/20		
Mar 21 '52	4/4		
Dec 3 '52	MAR 19 '58		
	APR 30 '58		
	OCT 25 1963	JAN 21 1966	

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